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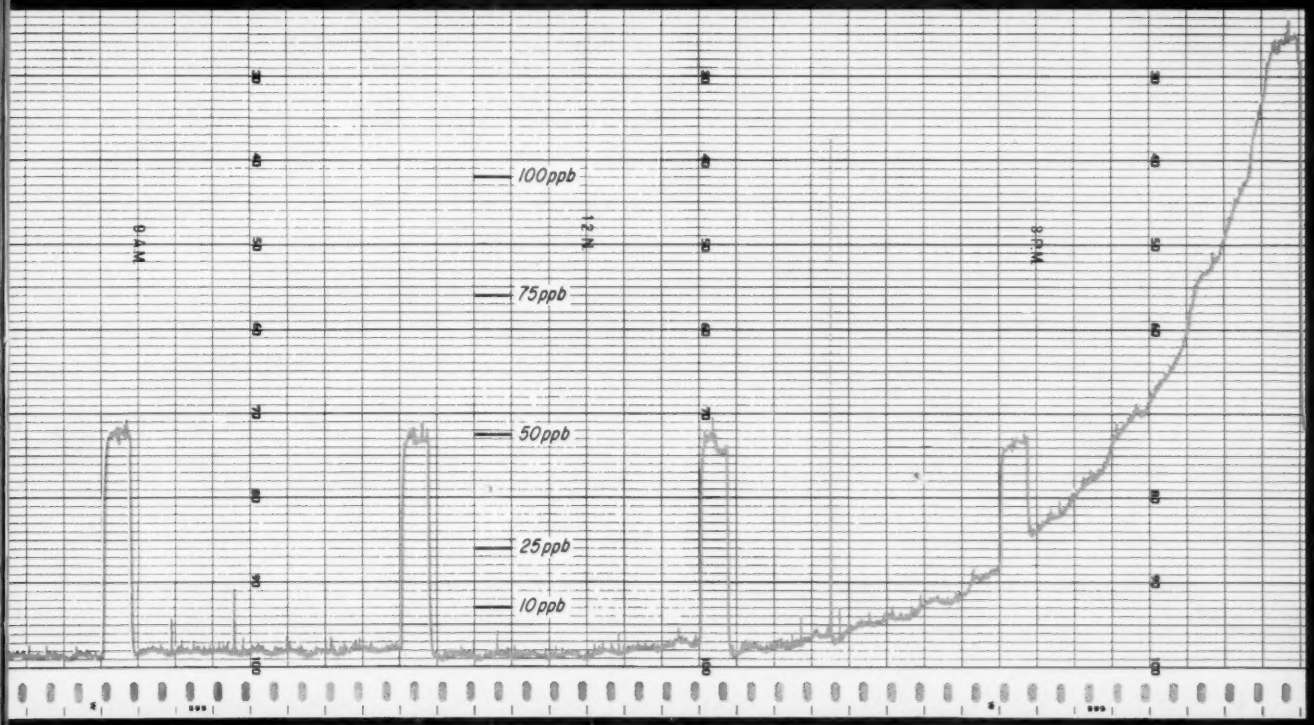
ONE DOLLAR

Power

the magazine of energy systems engineering



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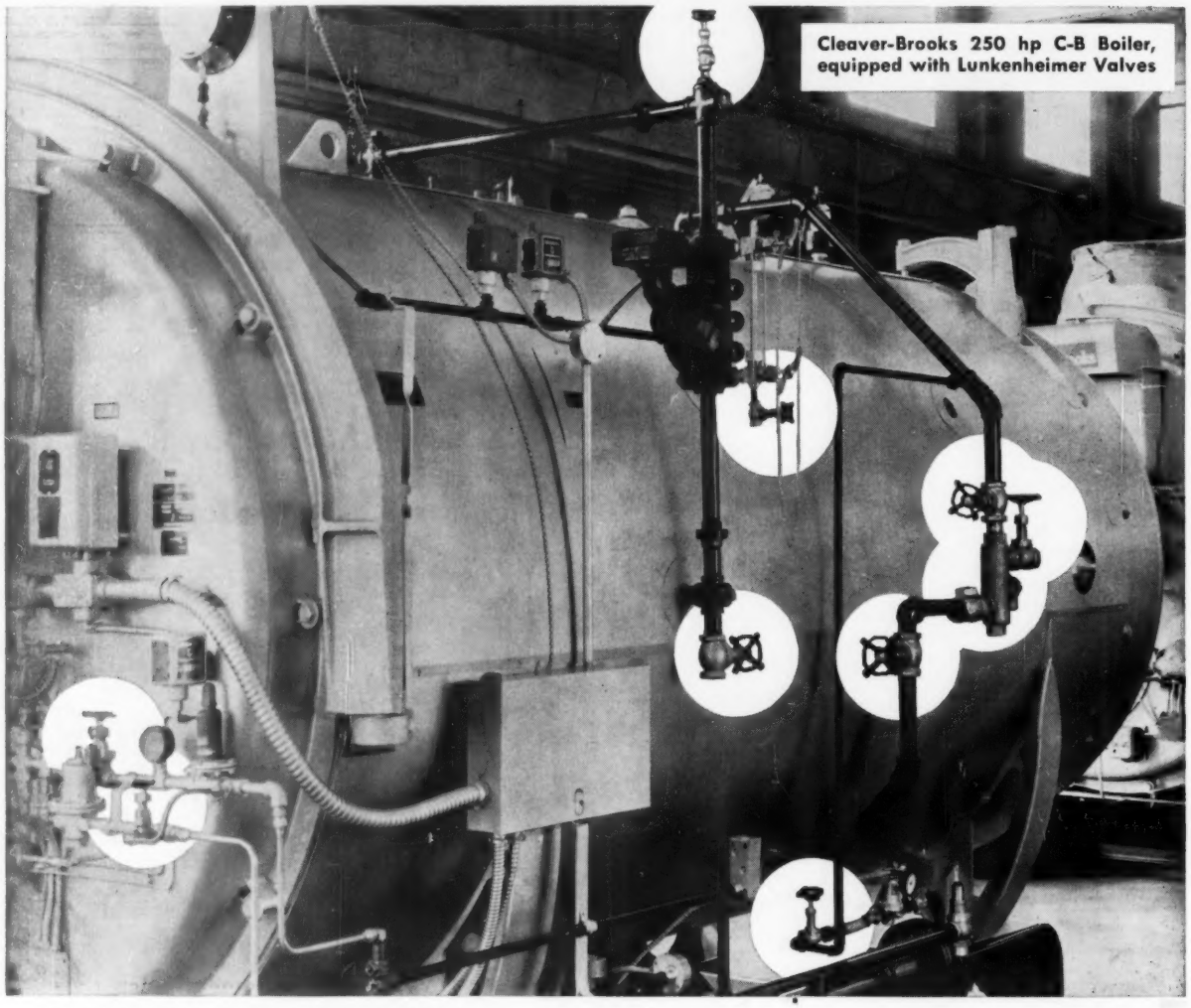

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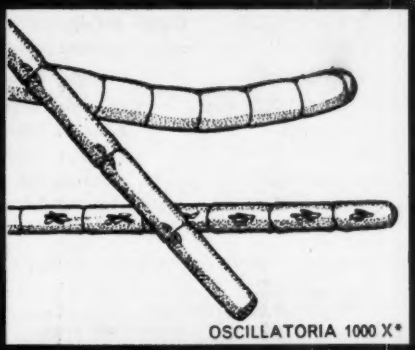
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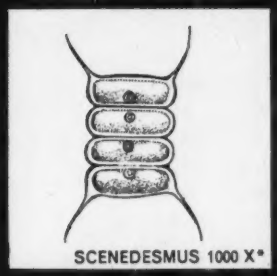
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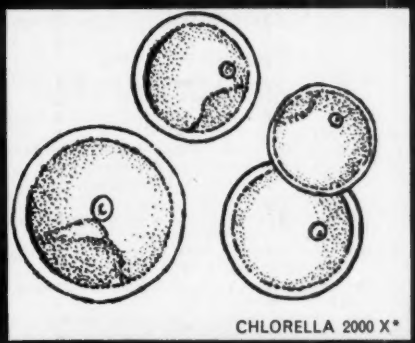
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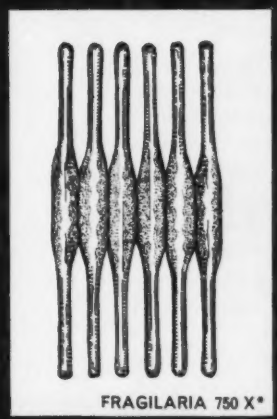
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speaking of **Power**

Incoming mail brought the following letter from Patrick D Goggin, Chief Engineer, Boiler Engineering & Supply Co, Inc, Phoenixville, Pa.:

"In the article *Guard against thermal shock* (April, pp 72 to 75) you state: 'POWER presents typical avenues of approach used by several manufacturers. We feel they are indicative of the entire industry's genuine concern with overcoming this problem.' It looks to me as if POWER's research people spent all their time with those manufacturers who had, and still do have, these problems. Do you not think that more constructive knowledge could have been gained by contacting a manufacturer who has never had these problems?

"The first hot-water boiler of our manufacture was delivered to the Scott Paper Co in Chester, Pa. on June 29, 1951. Since then, hundreds of units have been delivered to locations from Iceland to the Azores. To date we have not been able to locate one unit that failed due to 'thermal shock.'

"We have not been selective about location and application, nor have we imposed any restrictions on boiler-water temperatures other than those specified by the ASME Code, and have never restricted the temperature differentials.

"Approximately 60% of these units had higher-than-average heat-transfer rates: 3.5 sq ft of heating surface per bhp contrasted with the more common 5 sq ft per bhp."

Protective relays are taking on new importance in industrial plants as electrical-distribution systems get bigger and more complex. Next month, in a 24-page special report, Associate Editor Norm Peach outlines the many types of relays at your command, how they can be designed into fully coordinated schemes, the important role of instrument transformers in the overall protective plan.

Although protective-system designers are, in general, offering creditable plans to the industrial, these offerings are negated at times—after installation—by superficial maintenance . . . or none at all. So the report proposes practical tests for you to follow. Use them to stay out of trouble.

Lou Rowley

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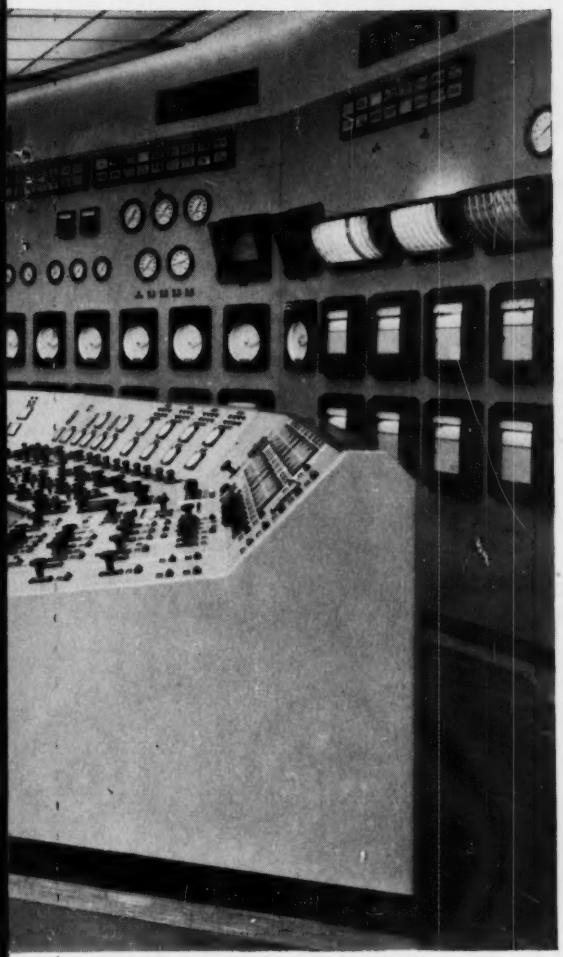
1959 STEAM-ELECTRIC PLANT HEAT RATES FROM FEDERAL POWER COMMISSION REPORT S-143

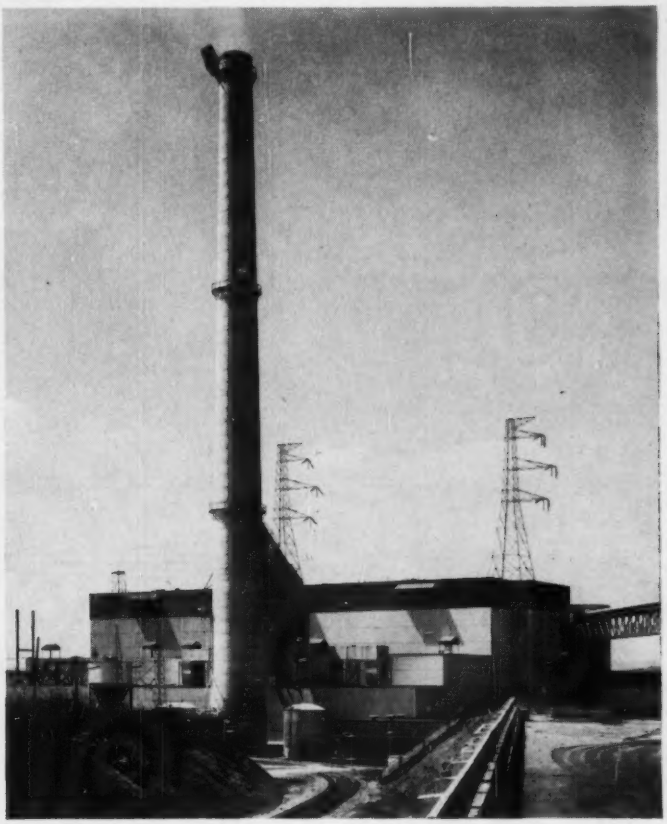
	Btu/kw-hr	Meters	Combustion Control	Feed Water Control	Superheat Control
1. Dickerson (Potomac Electric Power Co.)	9,007	B	B	B	B
2. Clinch River (Appalachian Power Co.)	9,011	B	—	B	B
3. Kanawha River (Appalachian Power Co.)	9,098	B	B	B	B
4. Silas McMeekin (South Carolina Electric & Gas)	9,130	—	—	—	—
5. Muskingum River (Ohio Power Co.)	9,170	B	B	B	B
6. River Rouge (The Detroit Edison Co.)	9,170	—	—	—	—
7. Clifty Creek (Indiana-Kentucky Electric Corp.)	9,173	B	B	B	B
8. G. G. Allen (Duke Power Co.)	9,174	B	B	B	B
9. Tanners Creek (Indiana & Michigan Electric Co.)	9,176	B	B	B	B
10. Shawville (Pennsylvania Electric Co.)	9,179	B	—	—	B
11. Kammer (Ohio Power Co.)	9,203	B	B	B	B
12. St. Clair (The Detroit Edison Co.)	9,250	B	B	B	B
13. Kyger Creek (Ohio Valley Electric Corp.)	9,284	B	—	B	B
14. Portland (Metropolitan Edison Co.)	9,322	—	—	—	—
15. Oak Creek (Wisconsin Electric Power Co.)	9,336	B	B	B	B
16. Bayshore (Toledo Edison Co.)	9,365	B	B	B	B
17. Milliken (N. Y. State Electric & Gas Corp.)	9,374	B	—	B	—
18. Philip Sporn (Appalachian Power Co.)	9,381	B	B	B	B
19. John Sevier (Tennessee Valley Authority)	9,390	—	—	—	—
20. Mandalay Beach (Southern California Edison Co.)	9,397	B	B	B	B
21. Gallatin (Tennessee Valley Authority)	9,420	—	—	—	—
22. Huntington (Southern California Edison Co.)	9,436	B	B	B	B
23. Colbert (Tennessee Valley Authority)	9,460	B	B	B	B
24. Will County (Commonwealth Edison Co.)	9,460	B	—	B	B
25. Agua Fria (Salt River Project A.I.F. Dist.)	9,473	B	B	B	B
26. Salem Harbor (New England Power Co.)	9,485	B	B	B	B

***per 1959 Heat Rates reported by FPC**

For more facts circle 205 on Reader Service card, p 101



Bailey Controls for combustion, feed water and steam temperatures at the Dickerson Generating Station of Potomac Electric Power Co. The Federal Power Commission reported a 1959 heat rate of 9007 Btu per kw-hr, ranking it as No. 1 plant in efficiency in the United States.



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and for 20 out of the next 25 "most efficient" plants, too

Most efficient power plant in 1959, as rated by the Federal Power Commission, was Dickerson Station of Potomac Electric Power Co. And for measuring and controlling functions that helped attain this record, Dickerson relies on Bailey Meters and Controls.

Moreover, *in 21 out of all 26* "most efficient" plants, with heat rates under 9500 Btu per kw-hr, Bailey Meters and Controls are used for some or all functions.

Why? The reasons aren't hard to find. Bailey engineers have worked hand-in-hand with leading power engineers for more than 45 years to advance steam-plant efficiency rates . . . have pioneered the research and development of improved measurement and control techniques that have produced much of today's high reliability of steam-plant operation . . . have simplified and verified instrumentation and control systems to the point where automation can be approached confidently.

And now, working to extend the benefits of automation over the full range of plant operations, Bailey offers systems incorporating advanced techniques for scanning, alarming, logging, computing, digital logic and sequencing . . . all co-ordinated with established analog equipment to provide maximum safety, economy and reliability . . . all compatible with the needs of power management, technical and nontechnical.

Ask your nearby Bailey District Office or Resident Engineer how new Bailey concepts and advanced systems techniques may be applied to your operations.

A-164-2

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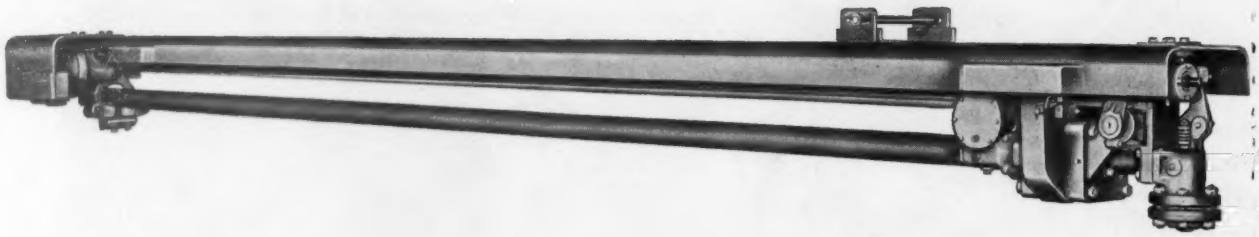

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Service tested on some 40 installations, Diamond Slurry Spraying offers a distinct economic advantage over fuel additives because it treats only that ash which collects on the tubes. Magnesium oxide-based slurry is sprayed on heating surfaces by conventional soot blowers modified to discharge, in alternate cycles, both the normal cleaning medium and slurry. The chemical slurry coating changes chemical composition of deposit so that it's easily removed by normal blowing.

If you burn — or are considering burning low-grade oil, it will pay you to take a close look at Chemical Slurry Spraying . . . another Diamond-Developed Boiler Cleaning System. At your request, our engineers will make recommendations based on your specific requirements. Call, write or wire for complete information.

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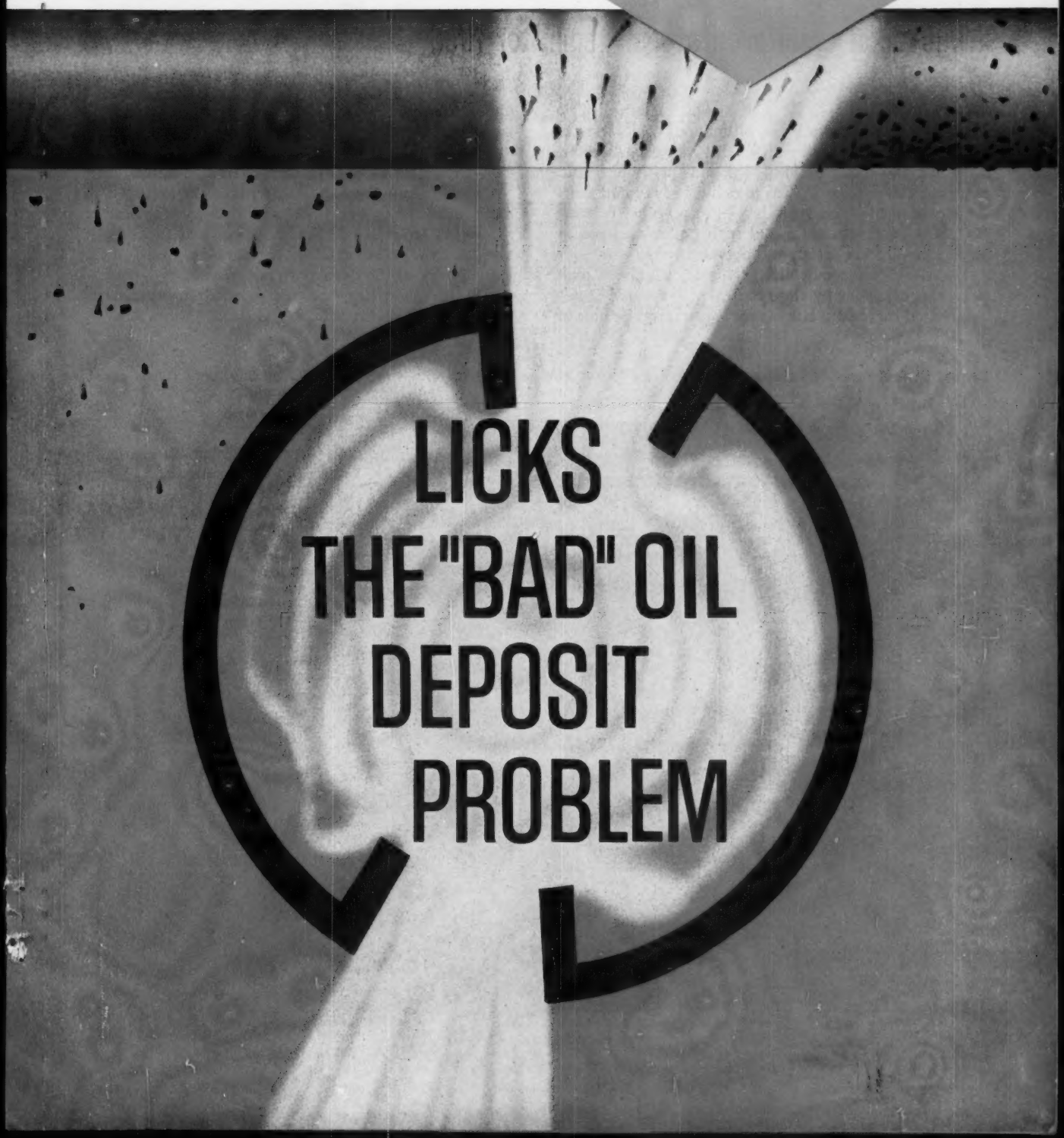


Copes-Vulcan automatic boiler control at Hammermill Paper Company

Gives good results on steam generator fired with hogged bark and coal

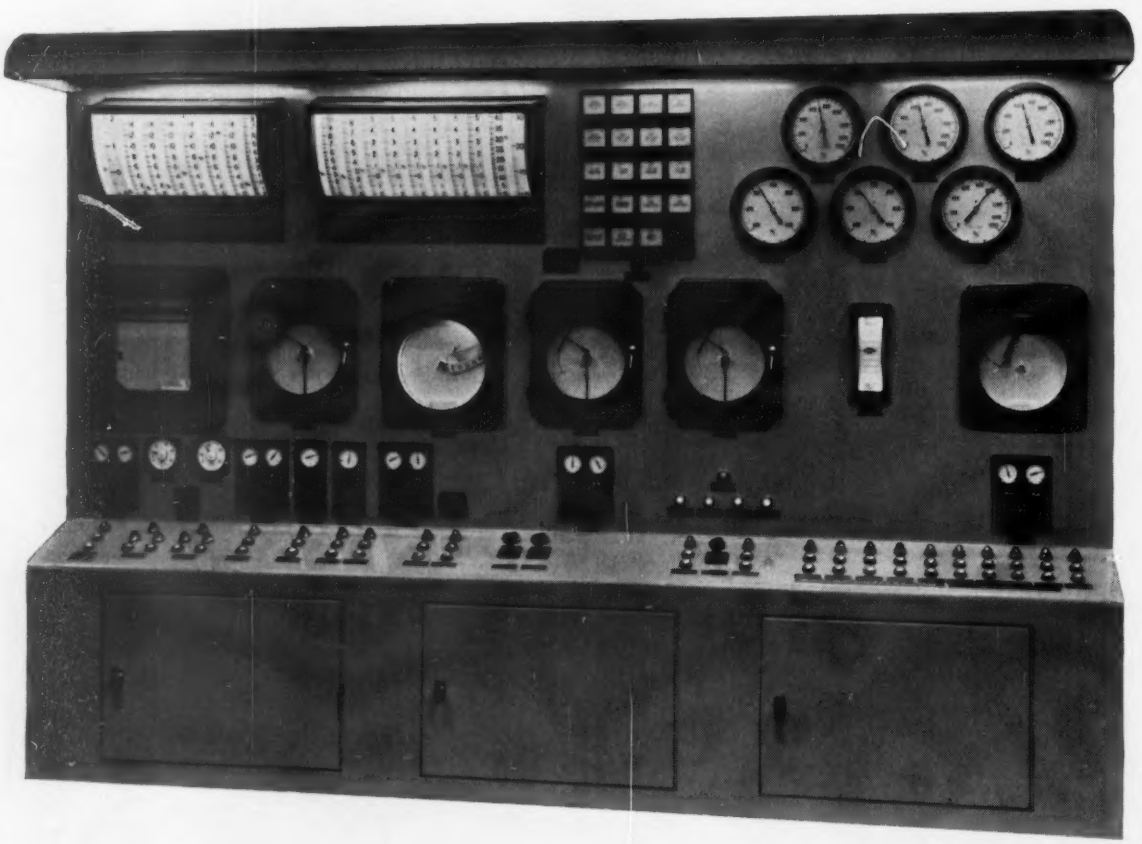
Here was an unusual problem of boiler control. Two solid fuels—hogged bark and bituminous coal—were to be burned in combination. The Riley steam generator, with nominal rating of 206,000 pounds per hour at 675 psig and 760 degrees F., was to deliver power and process steam to the same main header as all other existing boilers. Low steam costs and high boiler availability were a goal of the design and operating engineers.

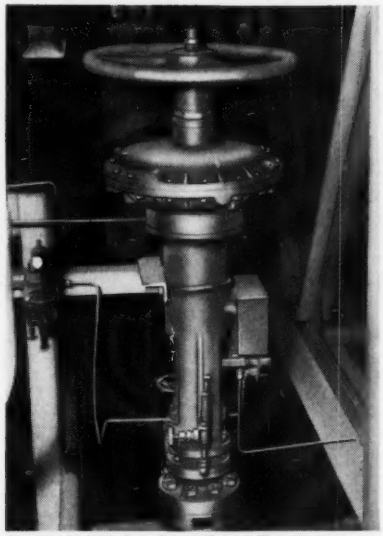
Copes-Vulcan combustion control has given high operating efficiency by close control of excess air. It has minimized fuel-bed disturbances by keeping the flow of air through the bed at the lowest practical rate. It has handled intermittent flows of waste fuel without incident. It has required no manual adjustments for variations in fuel moisture or quality, or in kind of fuel.

Copes-Vulcan three-influence feedwater control has maintained the proper drum level while feeding exactly as needed for steam output. Regardless of load conditions, Copes-Vulcan control has maintained final steam temperature at the desired 760 degrees F.

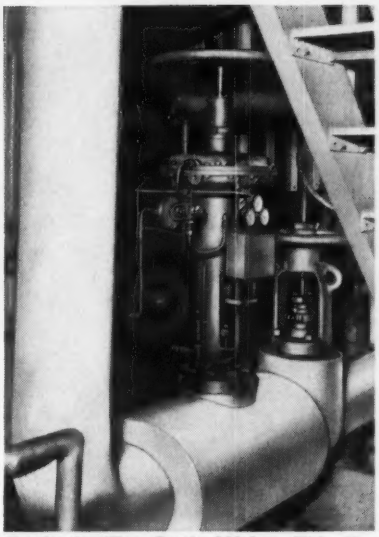
The complete story of this unusual installation is told in new Bulletin 1078. Write for it.

Central Control Panel. All recorders and controls for the bark-and-coal-fired boiler are centralized on this Copes-Vulcan panel.

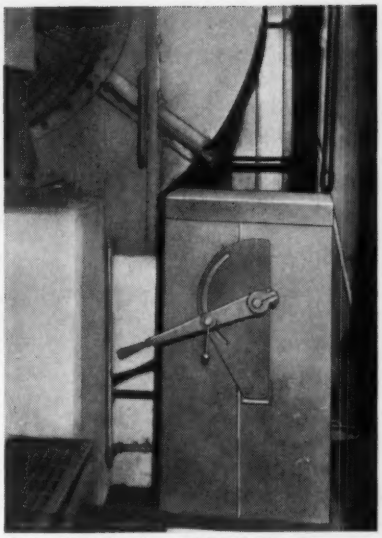




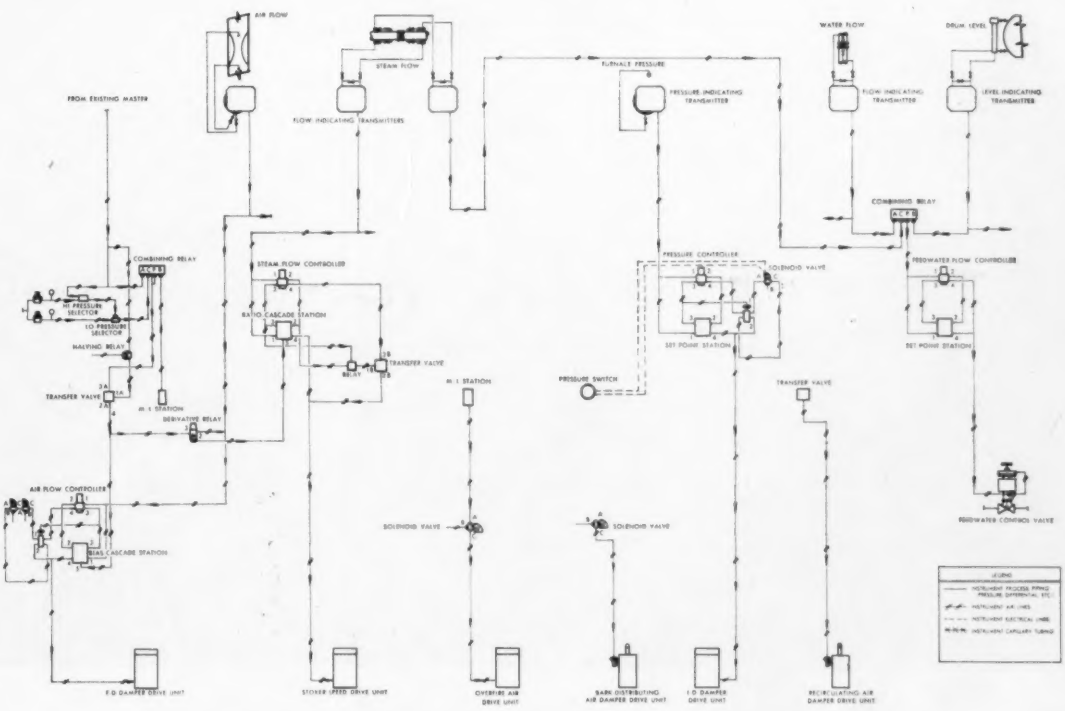
Spray Valve for Superheat Temperature Control. This Copes-Vulcan Type CV-D Spray Valve introduces cooling water into the superheater for dependably accurate steam-temperature control.



Feedwater-Flow Control Valve. This diaphragm-operated Type CV-D valve is part of the Copes-Vulcan three-influence feedwater control system.



Drive Unit for Forced-Draft Fan Damper. This Copes-Vulcan drive unit, one of several in the control system, positions the forced-draft fan damper.



Schematic diagram of the Copes-Vulcan combustion and feed-water control systems on the bark-and-coal-fired boiler at Hammermill Paper Company.

Copes-Vulcan Division

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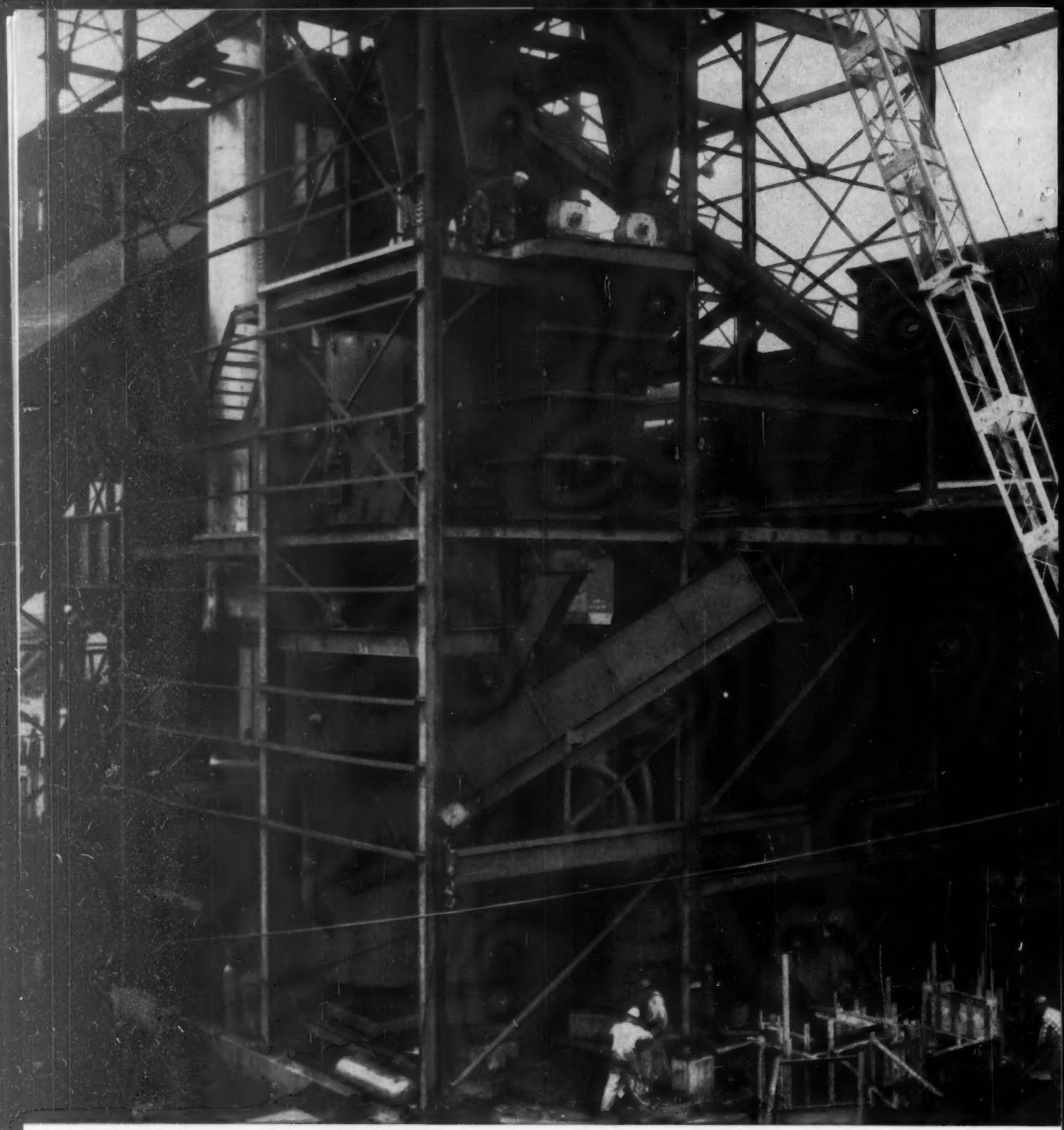


Progress Report: *Eastern's new cleaning plant at* ***Federal No. 1 mine, Grant Town***

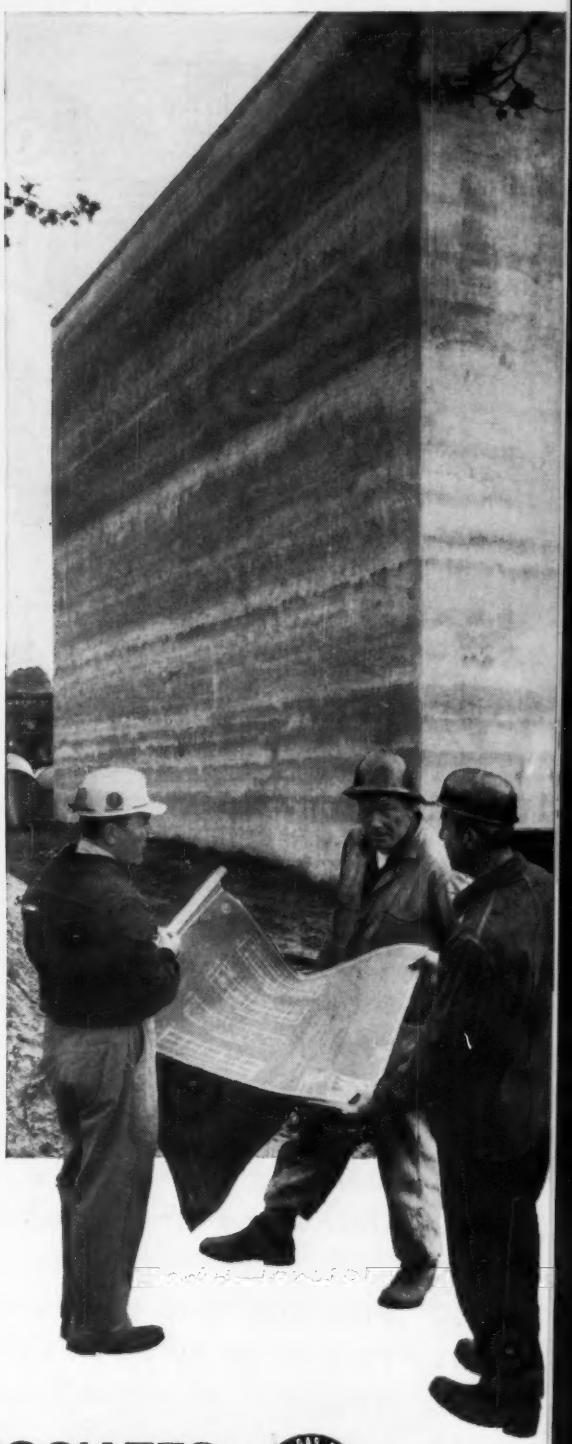
ON SCHEDULE

The construction of the new coal cleaning plant at Eastern's Federal No. 1 mine, Grant Town, W.Va., is proceeding on schedule.

Designed by Eastern's own engineering staff, the new plant will employ the most modern equipment, so arranged as to provide uninterrupted production at all times. This plant will produce a very high grade of steam coal.

(Left) Main plant showing the dryer at left, pulverizer (at base of dryer) and part of the dust collector system.

(Below) Company and contractor personnel check progress of 2500 ton capacity blending bin adjacent to main plant.



Federal No. 1 is one of a series of such cleaning plants now under construction or in the planning stage. These plants are evidence of Eastern's determination to continually improve their product and their service to customers.

If you would like a full description of the facilities at Federal No. 1, write or phone your nearest Eastern representative.

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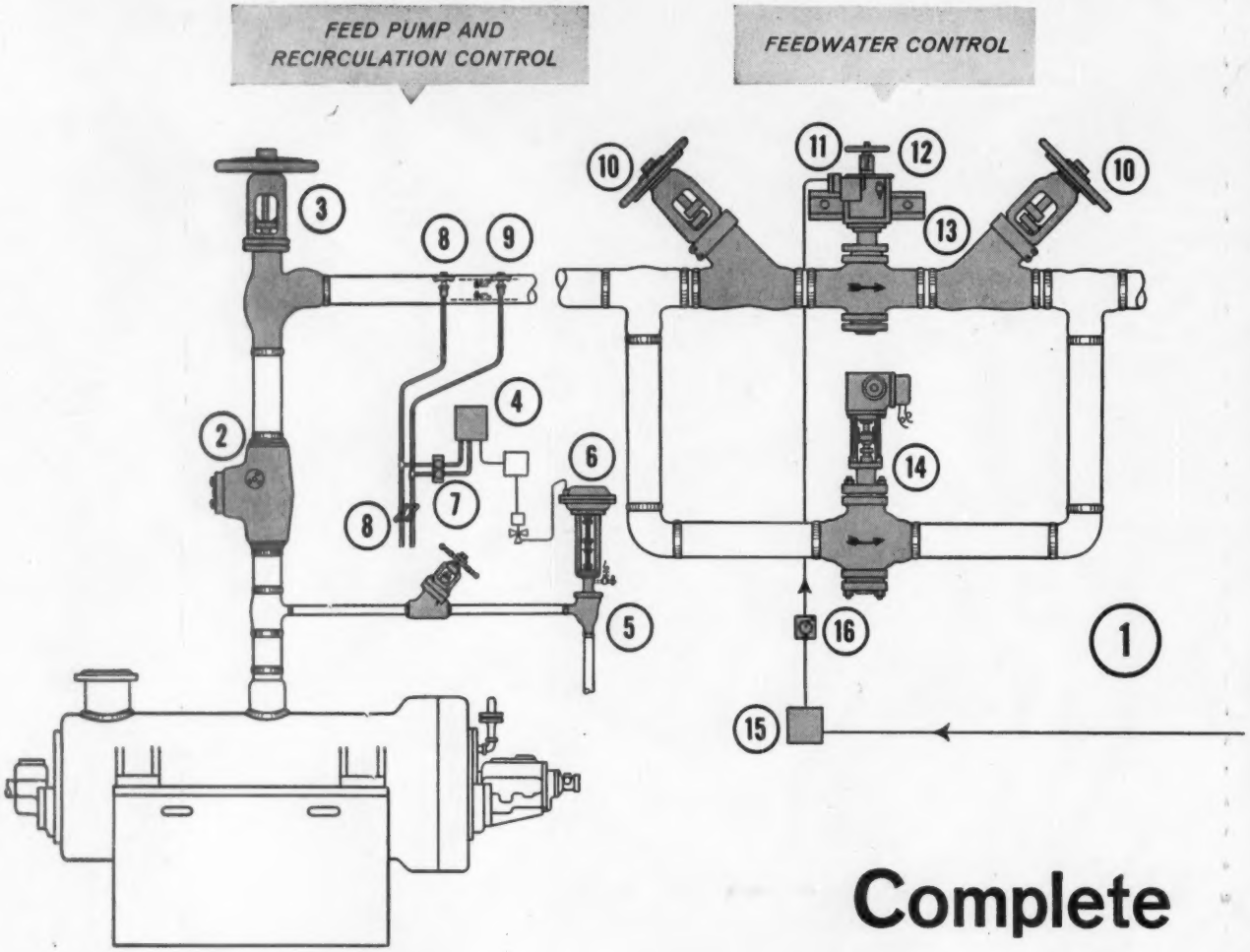
BEACON COAL

For more facts circle 208 on Reader Service card, p 101

Boiler feedwater

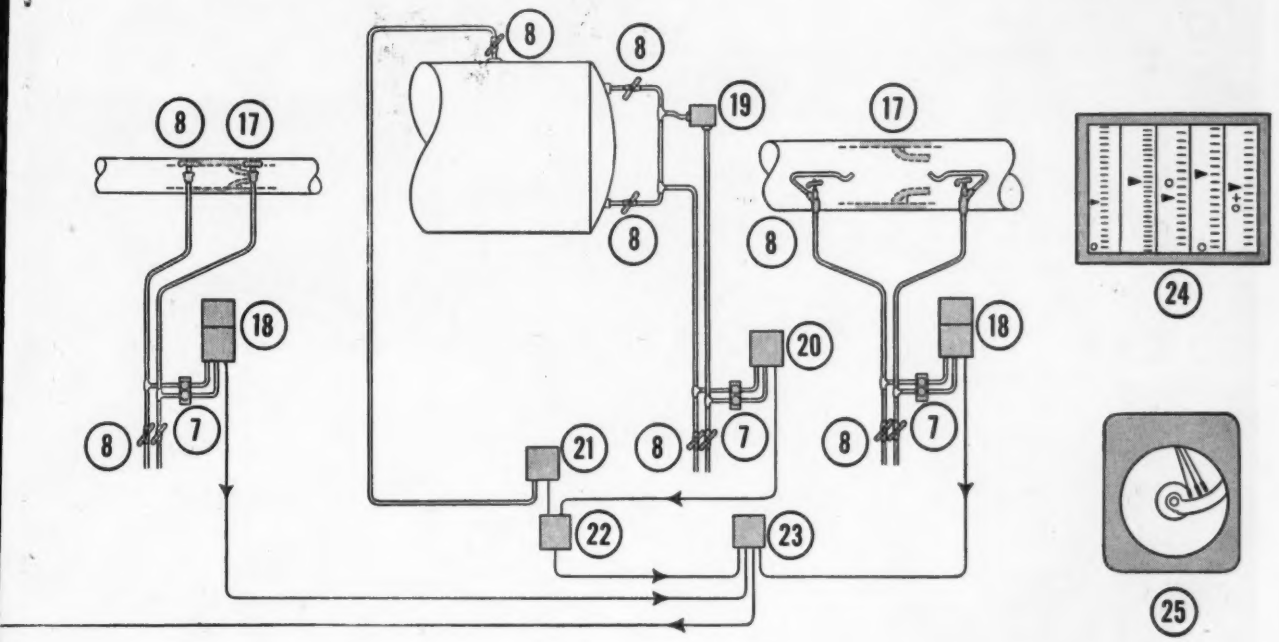


Complete

1	System engineering by	ROCKWELL-REPUBLIC
2	Tilting disk check valve by	ROCKWELL-EDWARD
3	Stop or stop-check valve by	ROCKWELL-EDWARD
4	Transmitter and controller by	ROCKWELL-REPUBLIC
5	By-pass angle valve by	ROCKWELL-REPUBLIC
6	Diaphragm operator by	ROCKWELL-REPUBLIC
7	Manifold valves by	ROCKWELL-REPUBLIC
8	Uni-valves for shut-off by	ROCKWELL-EDWARD
9	Orifice flow section by	ROCKWELL-REPUBLIC
10	Flite-flow stop valves by	ROCKWELL-EDWARD
11	Positioner by	ROCKWELL-REPUBLIC
12	Toggle head valve operator by	ROCKWELL-REPUBLIC
13	Control valve by	ROCKWELL-REPUBLIC
14	Motor-operated by-pass valve by	ROCKWELL-REPUBLIC
15	Level controller by	ROCKWELL-REPUBLIC

control system

FEEDWATER MEASUREMENT | *TEMPERATURE COMPENSATED DRUM LEVEL MEASUREMENT* | *STEAM FLOW MEASUREMENT* | *INDICATING AND RECORDING WHERE REQ'D*



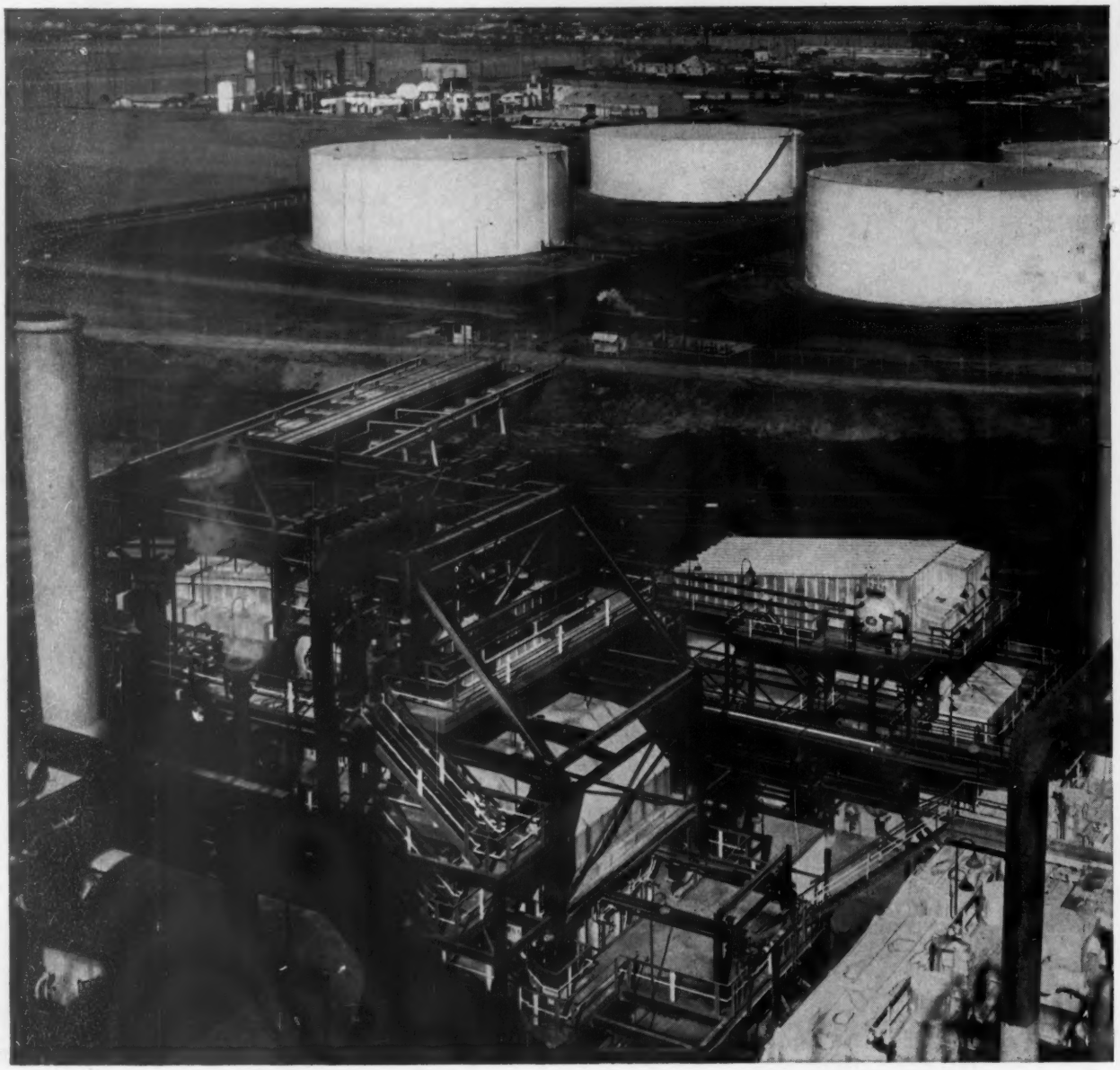
package from one source:

16	Manual-automatic control station by	ROCKWELL-REPUBLIC
17	Nozzle flow sections by	ROCKWELL-REPUBLIC
18	Flow transmitter with square rooting by . .	ROCKWELL-REPUBLIC
19	Constant level reservoir by	ROCKWELL-REPUBLIC
20	Level transmitter by	ROCKWELL-REPUBLIC
21	Pressure transmitter by	ROCKWELL-REPUBLIC
22	Compensating relay by	ROCKWELL-REPUBLIC
23	Combining relay by	ROCKWELL-REPUBLIC
24	Gauges by	ROCKWELL-REPUBLIC
25	Recorders by	ROCKWELL-REPUBLIC

RF-24

For full details on Rockwell-Republic boiler feedwater control systems, contact the Republic Engineer in your area. Or, write to Republic Flow Meters Company, Subsidiary of Rockwell Manufacturing Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada Ltd., Toronto.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL



At Richfield Refinery, B&W boiler "team" provides

dependable operation with maximum

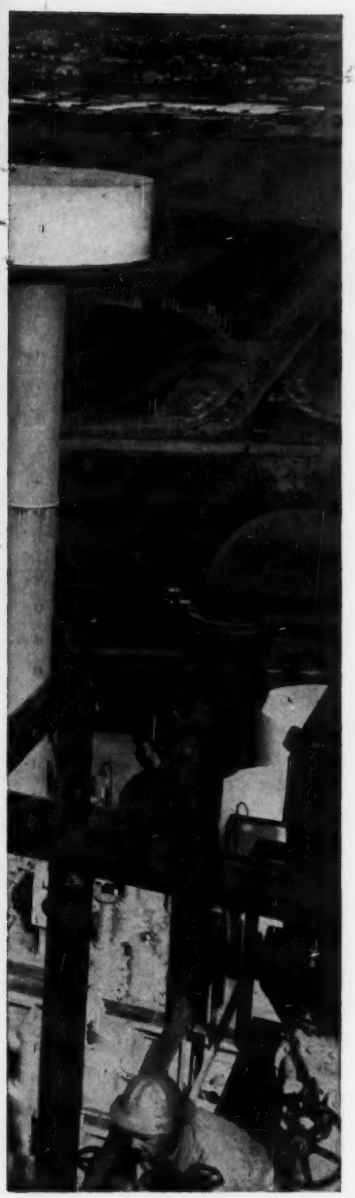
Two highly efficient B&W boilers of entirely different designs — system engineered into a money saving "team" — are providing operating flexibility and dependability at Richfield's Wilmington, California refinery.

The two boilers are the CO* Boiler, which operates on waste gases from the refinery process, and the PFI, which burns refinery gas, natural gas, or oil with equal ease.

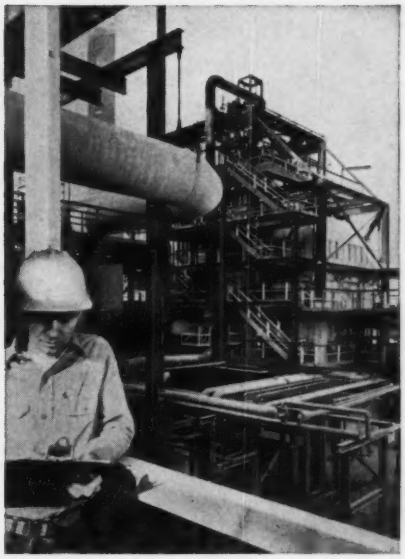
The CO Boiler has been base loaded at 340,000 lbs./hr. full load since its installation in 1954, with an availability exceeding 96%. Developed and pioneered by B&W, the CO Boiler improves refinery economy by burning cat-cracker gas that would otherwise be wasted. The Richfield unit is typical of the many CO Boilers that have solved air pollution problems.

Supplementing the steam produced by the CO Boiler, the PFI boiler is equipped to use the lowest cost auxiliary fuel, whether oil or gas, at all times.

*Reg. U.S. Pat. Off.

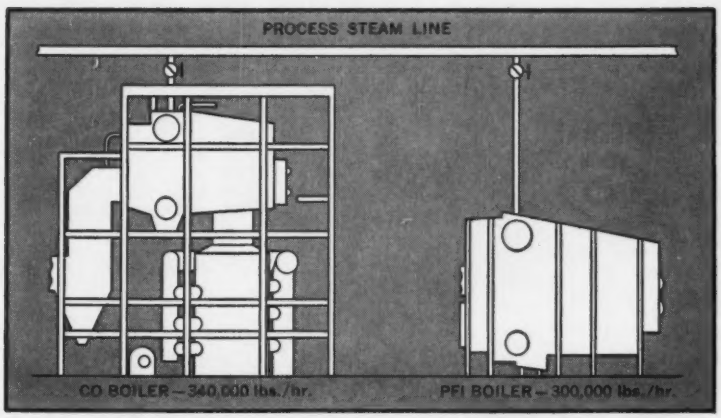


MAXIMUM AVAILABILITY — No unscheduled outages have occurred since the CO Boiler (left) and the PFI boiler (right) went on the line. This complete freedom from unscheduled shutdowns plus sustained high efficiency provides Richfield with dependable steam at 640,000 lbs./hr.



PAYS FOR ITSELF—Burning cat-cracker gas that would otherwise go up the stack and pollute the atmosphere, the B&W CO Boiler cuts operating costs to the extent that it, and others like it, pay for themselves in fuel savings in less than 3 years.

FLEXIBILITY OF OPERATION — The PFI boiler helps keep steam generation costs down by providing immediately all needed steam in excess of that which can be obtained by burning the waste gas.



EASY TO OPERATE, INTEGRATED CONTROL CENTER—Fully automated control center equipped with Bailey meters ties this boiler "team" together as a dependable source of low cost steam to meet refinery requirements.

fuel savings

This compact, versatile boiler, designed for 300,000 lbs./hr. supplies steam required in excess of that produced from the waste gases, and responds immediately to changing conditions.

By continually developing more efficient and economical ways to generate steam, B&W has helped many industries to meet growing steam demands at lowest possible cost. For further details, contact The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

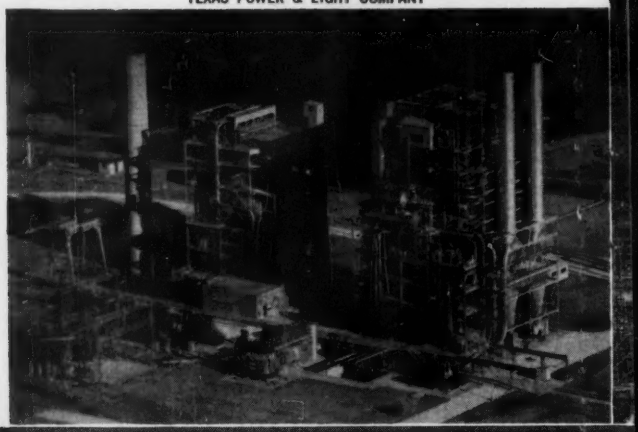
G-990-1B

B&W

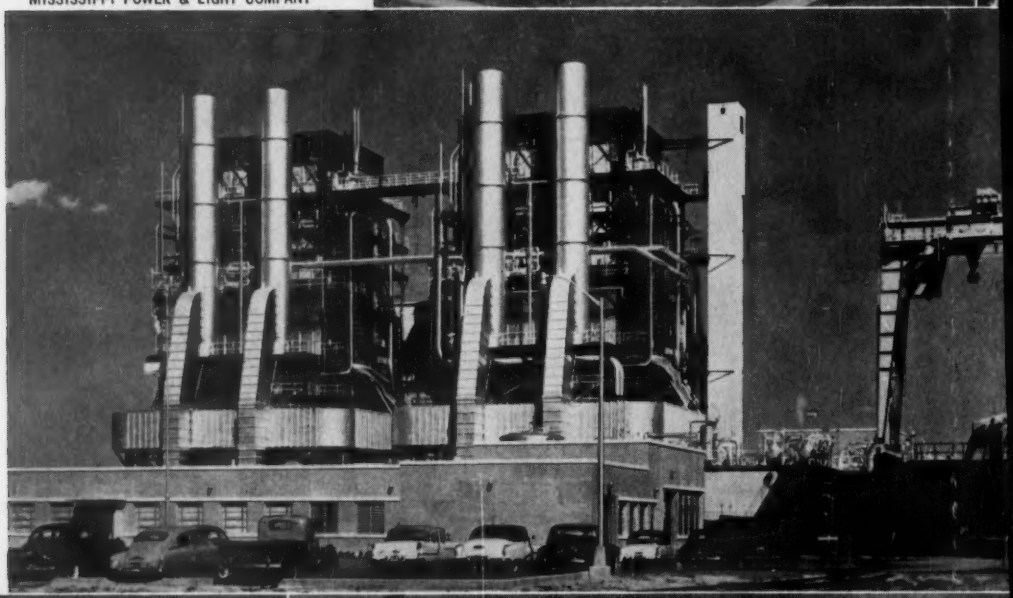
THE BABCOCK & WILCOX COMPANY

For more facts circle 210 on Reader Service card, p 101

TEXAS POWER & LIGHT COMPANY



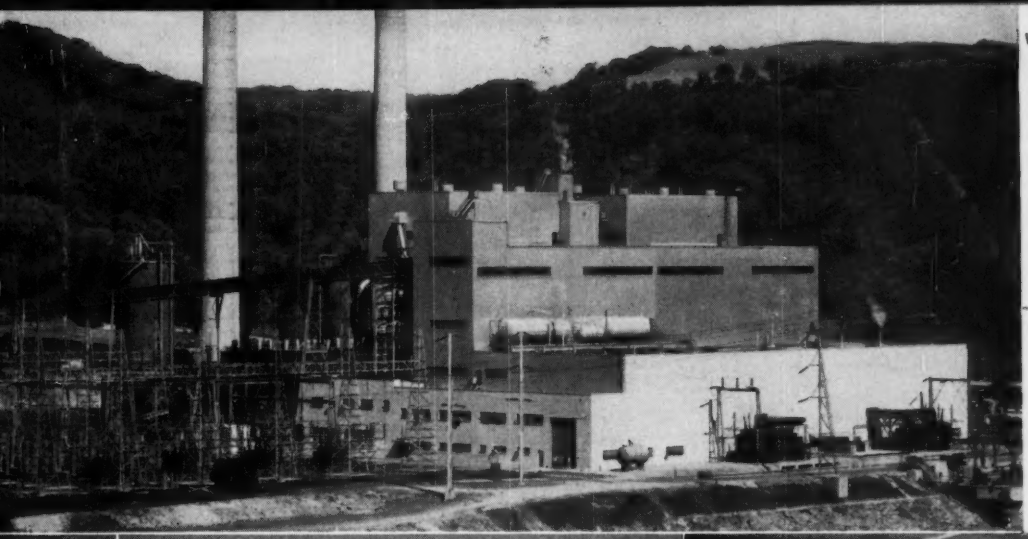
MISSISSIPPI POWER & LIGHT COMPANY



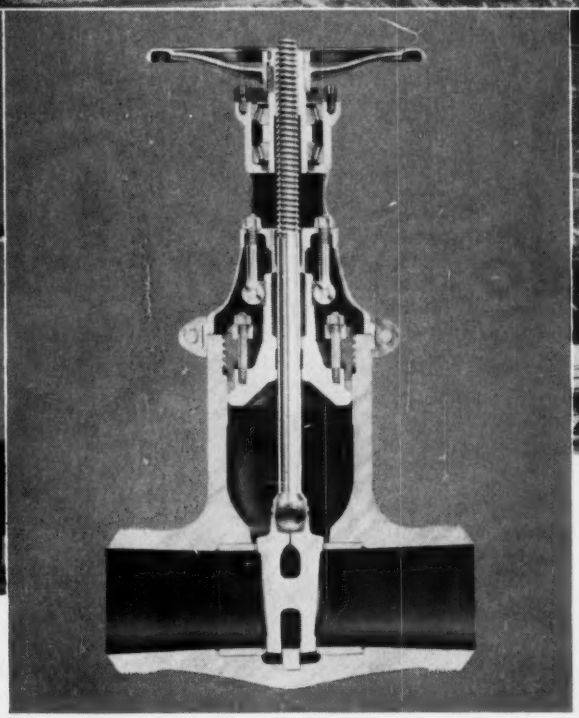
ARKANSAS POWER & LIGHT COMPANY

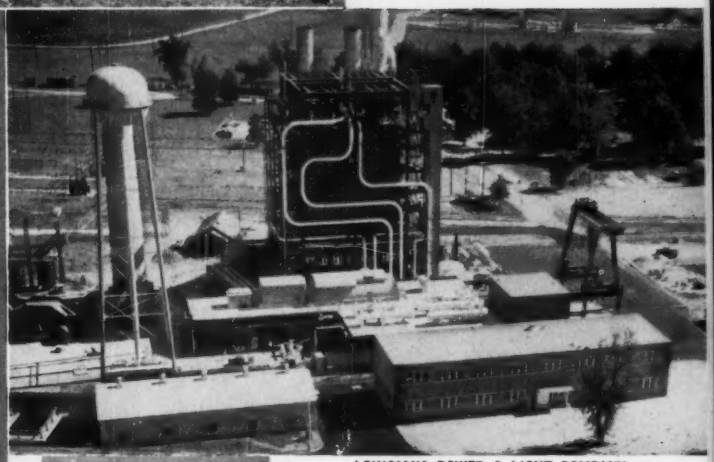
MINNESOTA POWER & LIGHT COMPANY

For more facts circle 211 on Reader Service card, p 101



WEST PENN POWER COMPANY





LOUISIANA POWER & LIGHT COMPANY

Power plants, coast to coast, rely on WALWORTH

Pressure - Seal cast steel valves

Power is going up! 39,153 Mw of new steam power are on drawing boards now. ■ Who will make the valves to control this torrent of steam? Walworth, of course, with Pressure-Seal Valves...also bronze, iron, steel valves...all types and sizes...for every steam plant application. ■ Wherever you must control fluid flow—remember Walworth. See your distributor. Walworth, 750 Third Avenue, New York 17, N. Y.

WALWORTH SUBSIDIARIES: Alloy Steel Products Co. ■ Conoflow Corp ■ Grove Valve & Regulator Co. ■ M&H Valve & Fittings Co. ■ Southwest Fabricating & Welding Co., Inc.

Six marked differences make Elliott turbines a better buy

Why are Elliott YR turbines your best choice for mechanical drives? Some of the reasons are described on the opposite page. These are tangible reasons why you can expect dependable, economical operation with little care or attention.

With more than 50 years' experience in mechanical-drive turbines up to 50,000 hp; with the most complete line of field-proven machines; with engineering and service facilities nationwide: Elliott is clearly "Turbine Headquarters." Write for bulletin H22-D.

TURBINES FOR DEPENDABLE day-in/day-out SERVICE

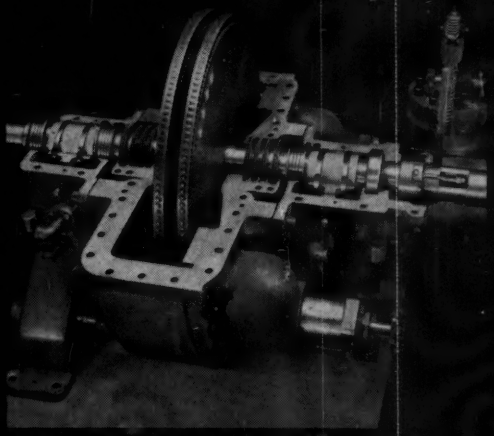
H1-1

ELLIOTT COMPANY

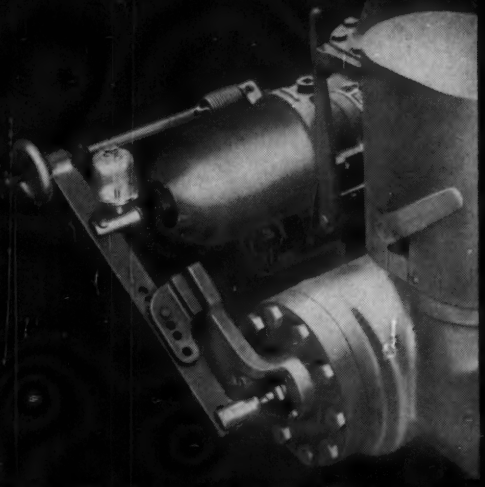
GENERAL OFFICES: JEANNETTE, PENNSYLVANIA
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES • GENERATORS • MOTORS • COMPRESSORS
TURBOCHARGERS • EJECTORS • STRAINERS • TUBE CLEANERS

For more facts circle 212 on Reader Service card, p 101



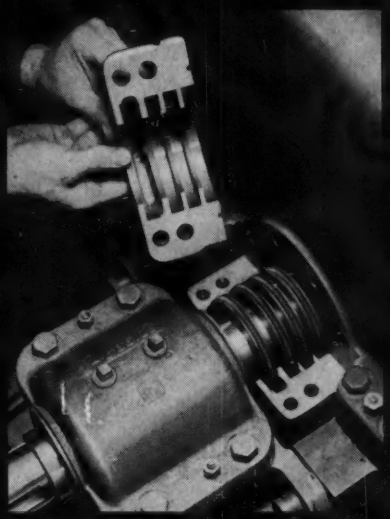
Precise alignment of shaft, through true centerline support, permits smooth and dependable operation at all operating temperatures.



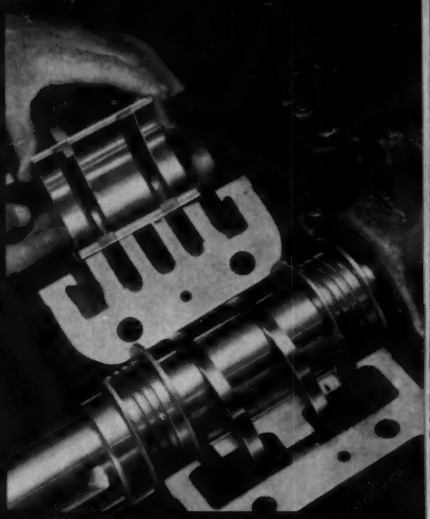
Simple, positive direct-acting speed-governing system is dependable, weather-proof, accurate. Separate trip gives positive overspeed protection.

These features mean dependable, economical turbine operation:

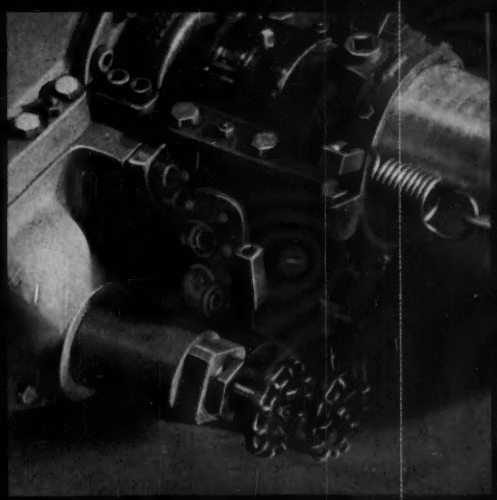
1. True centerline support
2. Positive speed control
3. Accaccessible shaft seals
4. Inexpensive bearings
5. Optional hand valve
6. Full protection



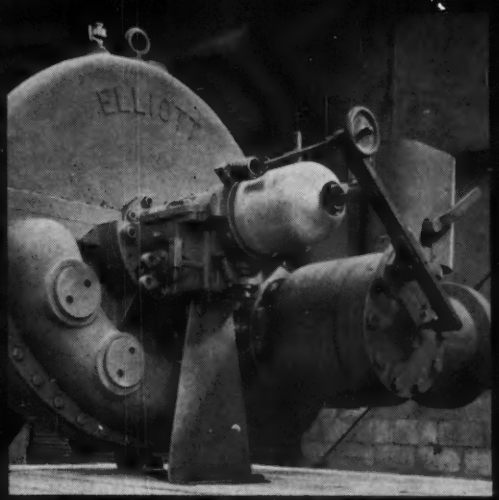
Accessible shaft-seals simplify maintenance and routine inspection. Covers readily removed without disturbing casing.



Inexpensive liner-type bearings readily installed with no scraping, fitting or adjustment required.



Steam-saving hand valve with pilot, which can be opened against full steam pressure, reduces steam consumption at partial loads.



All-weather protection is standard for Elliott YR turbines. They shrug off heat, snow, moisture, dust or contaminated atmosphere.

A telephone call brings out the best in him

The dictionary lists twenty-two definitions for the word service. For Tony Arobone there should be a twenty-third.

In his ten years of sales engineering for K & M, Tony has evolved a very personal and particular notion of what service means. But we doubt if he could (or would) put it into words. He's a doer, not a talker.

His customers can tell you about it. Tony's the guy you call when you need help. That includes help in working out valve specs, hounding the factory to ensure on-time delivery, supervising installation and hook-up—even getting a replacement part for you in a hurry (his service doesn't end with the ringing-up of the sale).

Tony's readiness to assist customers in any and every way isn't simply a matter of knowing which side your bread is buttered on—although it is obviously good business. A former working engineer himself, Tony knows what it's like to bear project responsibility, and a good bit of his desire to be helpful can be ascribed to honest identification with the man on the other side of the desk. He has been in your shoes, and he knows they sometimes pinch.

Most K & M representatives are former practicing engineers. When you sit down with them to talk over a valving job, you'll find they speak your language.

K&M

KIELEY & MUELLER, INCORPORATED

64 Genung Street, Middletown, New York

Eighty-two Years of Service to the Process and Power Industries

For more facts circle 213 on Reader Service card, p 101

SA-2403

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD

HOW YOU CAN SAVE MAINTENANCE...INCREASE OPERATIONAL TIME WITH YARWAY COLOR-PORT GAGES

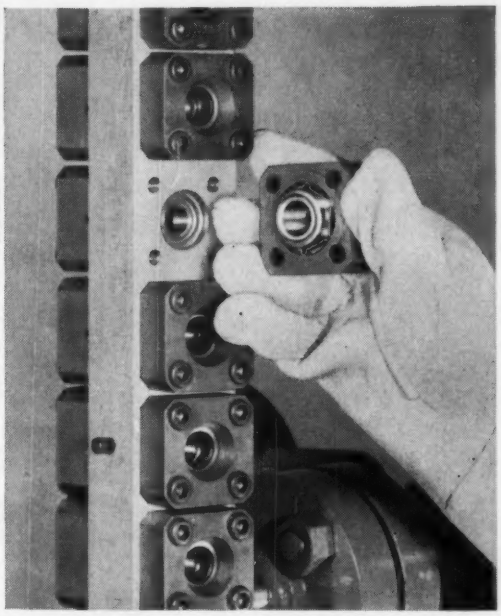
Two big problems confronting the operators of high pressure boilers—excessive maintenance and frequent downtime of water level gages—can be solved with new Yarway Color-Port Gages.

These Color-Port features will help you do the job:

- Patented spring loading of individual port covers, maintains proper pressure on glasses and gaskets at all times.
- Maintenance work can be done *with the gage in place.* NO TORQUE WRENCHES NEEDED!
- Individual "package" port assemblies (glass-mica-gasket) can be replaced in a few minutes.

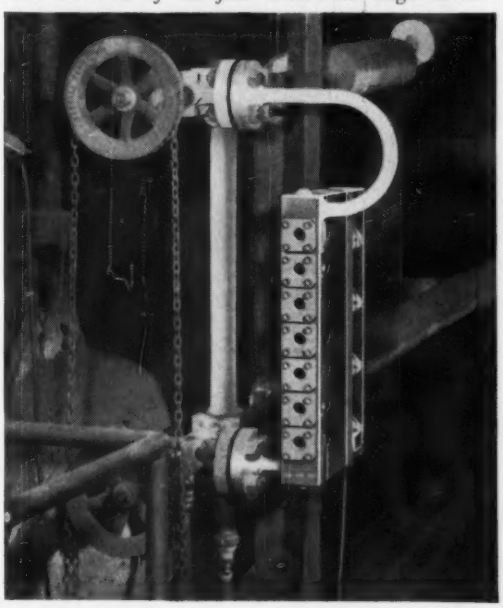
These benefits, PLUS brilliant two-color readings (water space shows green; steam space shows red), PLUS Yarway quality—make COLOR-PORT your best gage buy! 2 Series—1050 psi and 3000 psi.

Write for Yarway Bulletin WG-1815.

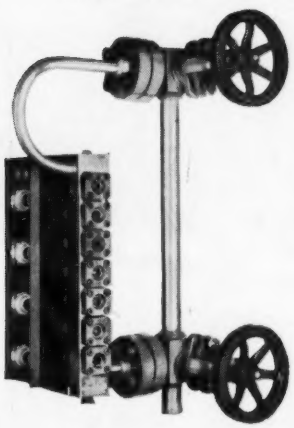


Servicing the Yarway Color-Port Gage is simple! Just remove 4 cap screws (no need for torque wrench), place new "package" assembly in cover, and replace cover assembly. A matter of two or three minutes.

Yarway Color-Port Gage installed on boiler at Alan Wood Steel Co. Leading industrial plants all over the country as well as many major utilities are among the hundreds of satisfied Color-Port Gage users.



NEW COMPACT DESIGN WITH "WELBLOC" VALVES SAVES INSTALLATION SPACE



New "Welbloc" valves on Yarway Color-Port Gages reduce installation space requirements up to 40%. All working parts of valves are easily accessible. Improved direct flow from boiler drum to gage, reduces temperature differential.

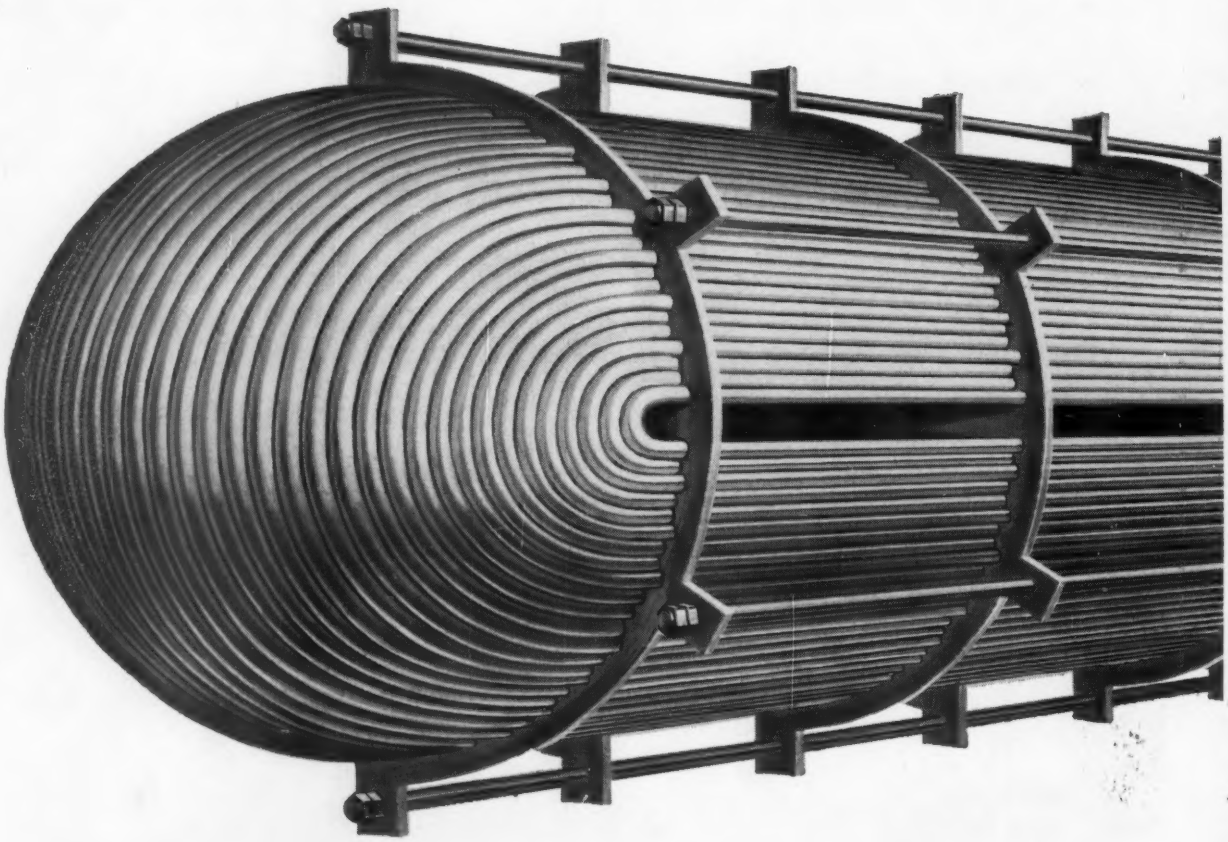
For more facts circle 214 on Reader Service card, p 101

Another New Extra High Strength
Condenser Tube Developed by

PHELPS DODGE!

CUFENLOY-40

With 15% Higher Strength than
any other Copper-Nickel Alloy
Now Available!



For more facts circle 215 on Reader Service card, p 101

In August 1959, Phelps Dodge introduced the first high strength copper-nickel alloy condenser tube, Cufenloy-30. Now Phelps Dodge offers Cufenloy-40, a copper-nickel alloy with greatly increased strength suitable for the most severe applications in high pressure feedwater heaters. The mechanical and physical properties of this exclusive new alloy make possible substantial reductions in the cost of feedwater heaters. Cufenloy-40 has received approval for ASME Code applications through Case 1300 (Special Ruling).

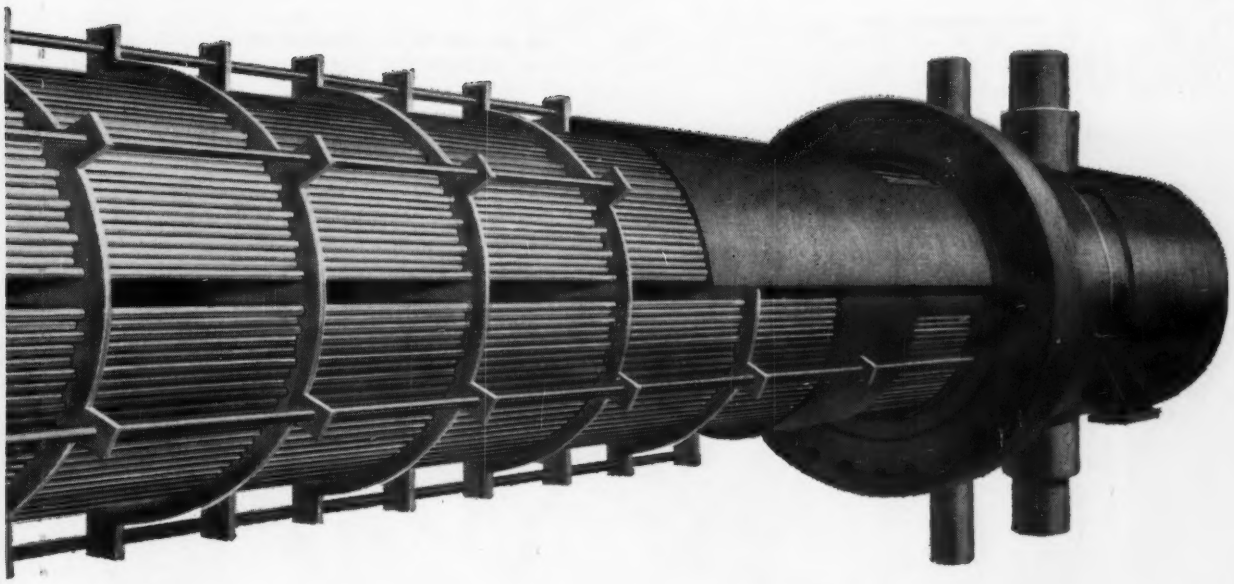
Weldability. Extensive tests in Phelps Dodge's laboratories were performed to determine Cufenloy-40's welding characteristics. Standard welding procedures used for 70/30 copper nickel tubes were found to be fully acceptable for this new composition. Pull-out, Cycling and Pressure Tests confirmed that a maximum joint efficiency was obtained using these procedures.

Corrosion Resistance. Corrosion studies have been performed on Cufenloy-40 since 1959 and have shown it to be unsusceptible to stress corrosion cracking in a moist ammonia and carbon dioxide atmosphere. In these tests Cufenloy-40 also proved virtually immune to general chemical attack. It is believed that Cufenloy-40 has the best overall corrosion resistance of the copper-nickel alloys.

Dual Gauge. Cufenloy-40 condenser tubes are available in dual gauges wherever a thickened wall section is needed to compensate for thinning on tight radius bends.

U-Bent Tubes. Cufenloy-40 tubes are also furnished in factory "U" bends for immediate tubing into the unit at the manufacturer's plant or on the job site.

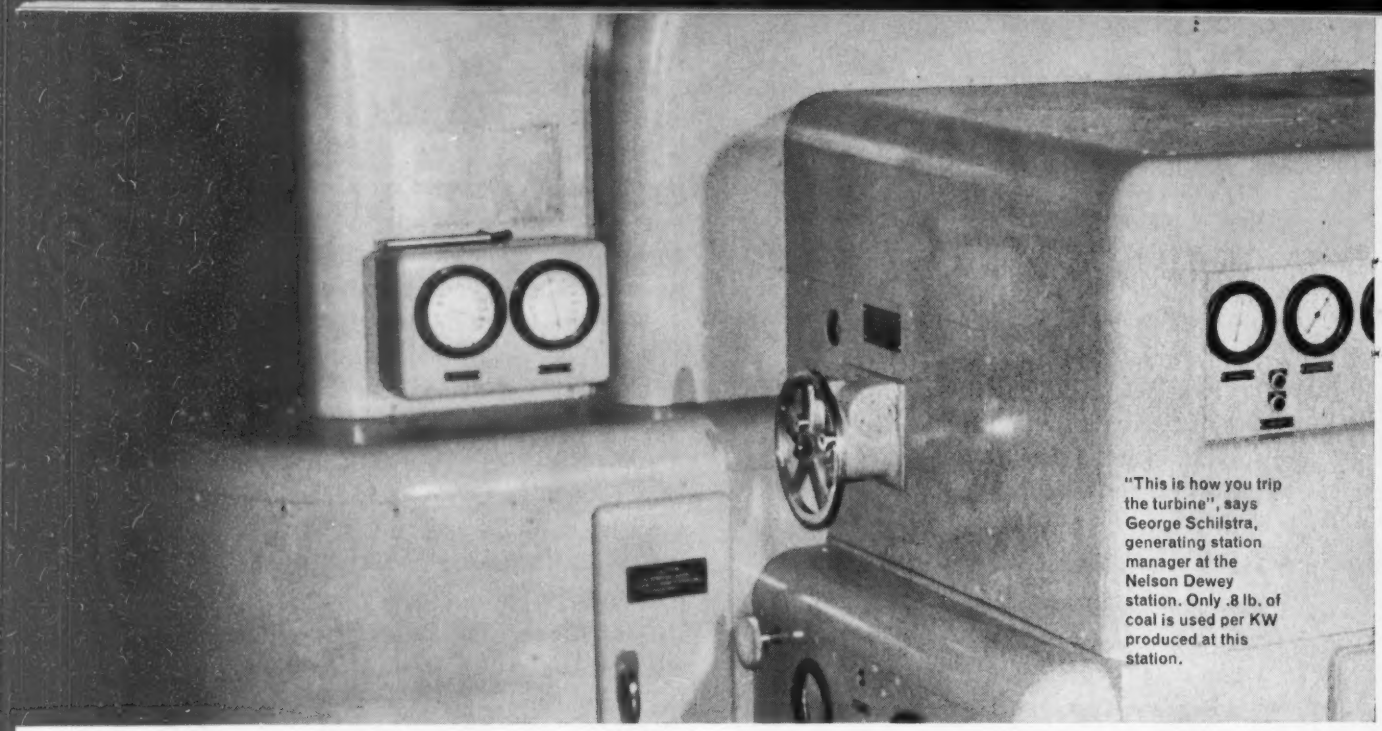
Further Information from your local Phelps Dodge sales office, or write Dept. 2A for the Cufenloy-40 technical brochure.



PHELPS DODGE COPPER PRODUCTS
CORPORATION
300 Park Avenue, New York 22, N.Y.

MINE TO MARKET

Circle 216 on Reader Service card for following ad



"This is how you trip the turbine", says George Schilstra, generating station manager at the Nelson Dewey station. Only .8 lb. of coal is used per KW produced at this station.

BY R. C. "ROLLY" BLEIMEHL

About the Author. Rolly Bleimehl has been providing technical service on lubrication to customers of our parent company for fifteen years. He has a mechanical engineering degree from Iowa State College and has completed the Company's Sales Engineering School at Whiting, Indiana.

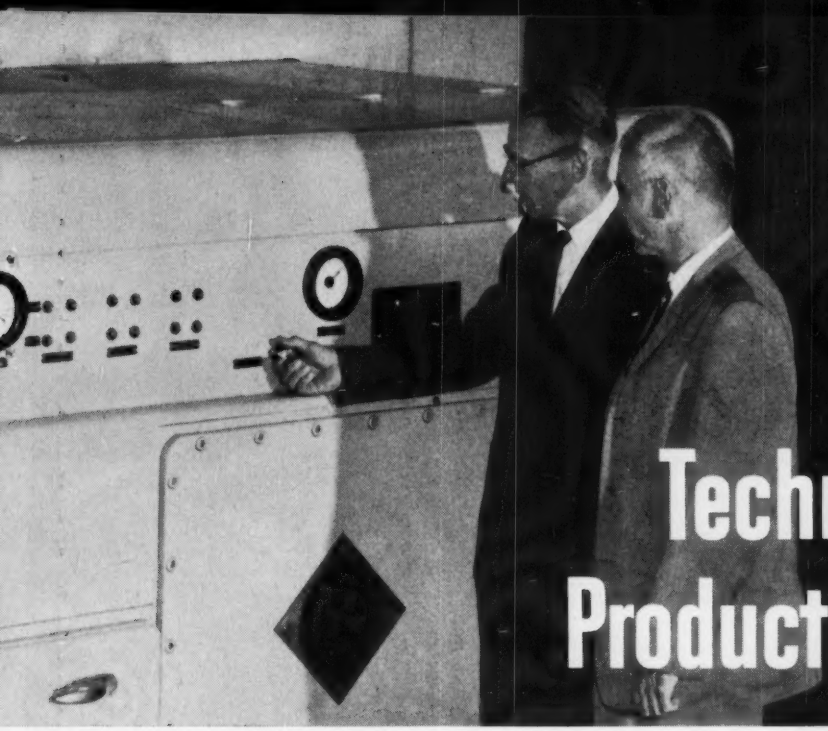
★ ★ ★

In 1954, when the first of two 75,000 KW turbines went into service at Wisconsin Power & Light Company Rock River generating station, Beloit, management had to make a decision on a turbine oil. Two factors helped them decide in favor of NONPAREIL Turbine Oil: (1) NONPAREIL's performance history and (2) the technical service available from American Oil Company.

Performance history: Each fill of NONPAREIL Turbine Oil carries with it a life-of-turbine guarantee. This means that if, during the life of the turbine, the neutralization number of the oil ever rises above the low limit of 0.15, the oil will be replaced free of charge. Some fills of NONPAREIL Oil have been in service more than 35 years under this life-of-turbine guarantee.

Technical service: I'm located at Madison, only a short distance from Beloit. Thus, I'm always handy to make periodic calls at the station to answer questions about the oil. And we take samples of the oil regularly for analysis at our Whiting, Indiana, laboratory (at no expense to the utility).

Putting these two together —product performance and technical service—Wisconsin Power & Light Company decided it made good sense to specify NONPAREIL Turbine Oil. The satisfactory performance of the oil in the first turbine at Beloit helped the management decide on



This is
AMERICAN OIL COMPANY
in action

Technical Service, Product Performance

--two reasons why this utility selected

NONPAREIL Turbine Oil

it for the second 75,000 KW unit when it was installed in 1955. For the same reason management selected NONPAREIL when their 100,000 KW turbine went into service at the Nelson Dewey station, Cassville, Wisconsin, in 1959.

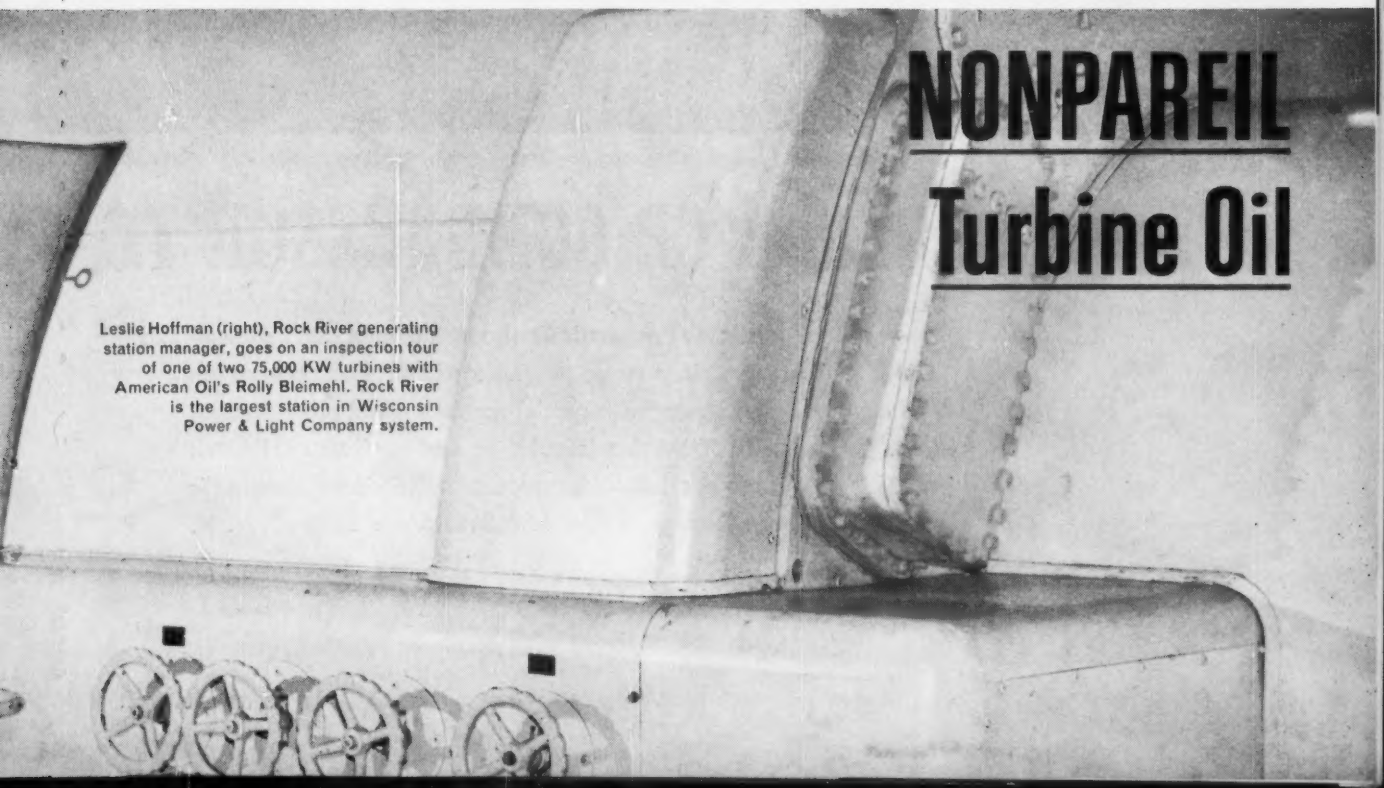
Get more information about NONPAREIL Turbine Oil and about the lubrication technical service that is available. Phone your nearby American Oil Company office.

Quick facts about **NONPAREIL Turbine Oil**

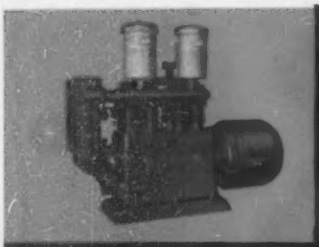
- Will not permit formation of harmful acids.
- Will not permit formation of sludge or oil varnish.
- Will maintain good demulsibility or water-separating characteristics.
- Has high resistance to foaming.
- Contains adequate rust inhibitor.

AMERICAN

AMERICAN OIL COMPANY
910 S. Michigan Ave., Chicago 80, Ill.

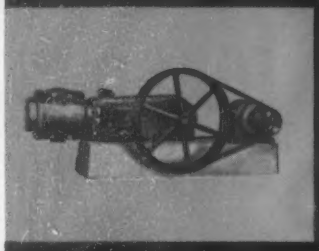


Leslie Hoffman (right), Rock River generating station manager, goes on an inspection tour of one of two 75,000 KW turbines with American Oil's Rolly Bleimehl. Rock River is the largest station in Wisconsin Power & Light Company system.

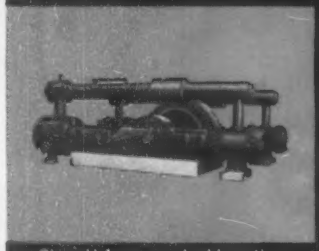


Class P single-acting air-cooled; capacities to 554 cfm.

Class Y double-acting, water-cooled; capacities to 2050 cfm.



Class T double-acting, water-cooled; capacities to 688 cfm.



Class H 4-corner, double-acting, water-cooled; capacities to 10,000 cfm.

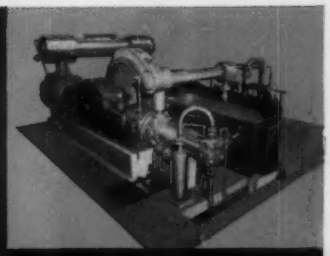
plant air

One of four 800 hp Class O-CE Compressors serving a large steel mill. Capacities to 6,000 cfm.

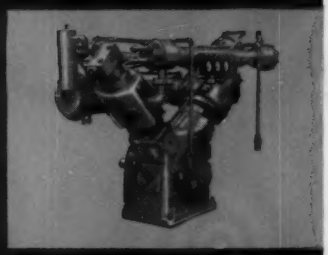
THERE'S A CP COMPRESSOR TO

There's a Chicago Pneumatic Compressor to meet every demand for general plant air. And, in process work, CP Compressors are handling most known gases with special regulation and other features tailored for each job, and with lubricated or non-lubricated cylinders. For full information write: *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

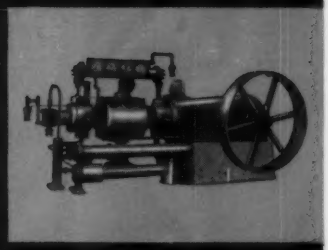
process gas



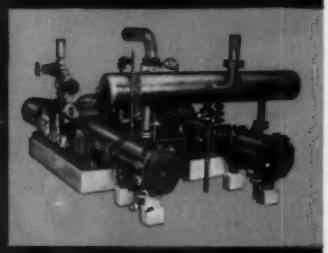
Class H, 5-stage;
700 to 2,000 hp.



Class Y, 4-stage; 75-300 hp.



Class T, 4-stage; 20 to 150 hp.



Class H, steam-driven;
350-1250 hp.

Class FE-33 horizontal, balance-opposed, 3-throw, 3-stage gas compressor. Sizes 250-5,000 hp.

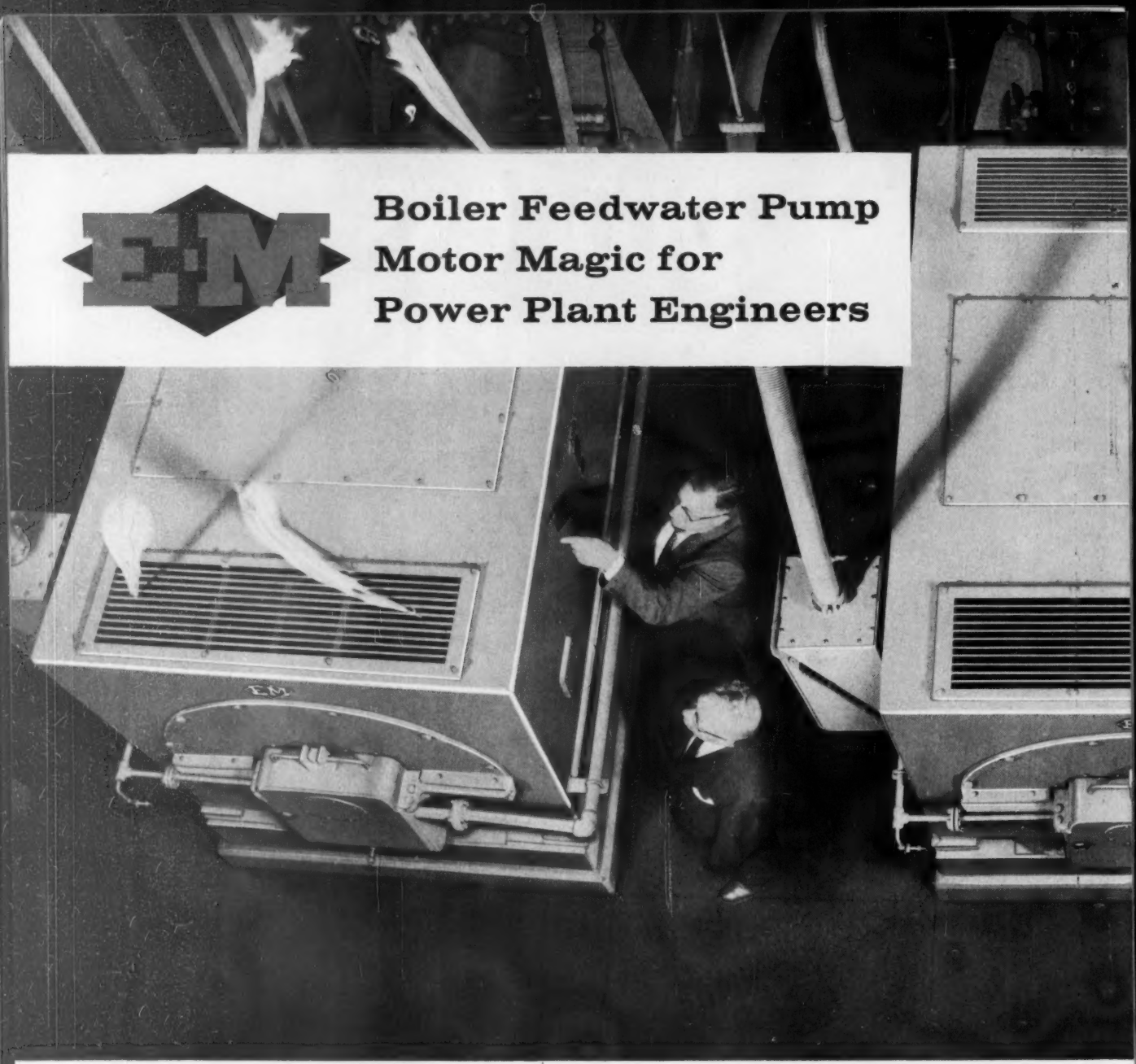
MEET YOUR EVERY NEED

- *sizes to 5,000 hp*
- *vacuum service*
- *pressures to 15,000 psig*

Chicago Pneumatic

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC AND ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

For more facts circle 217 on Reader Service card, p 101



Boiler Feedwater Pump Motor Magic for Power Plant Engineers

Shown above are three E-M Straight-Up-Ventilated Squirrel-Cage Induction Motors driving boiler feedwater pumps at High Bridge Station, Northern States Power Company, St. Paul, Minnesota. Each motor is rated at 2500 hp, 3600 rpm,

Straight-Up Ventilation Gives

The space-saving secret is in the natural air-flow design of E-M's Straight-Up-Ventilated Motors.

With straight-up ventilation, each motor takes in cool, clean air from both sides near floor level, circulates it in and around all operating components. The warm air is then discharged *through the top* of the motor housing. Natural convection carries it up and away where it can't heat up adjacent motors.

Thus cross-circulation and recirculation are effectively halted. Each motor has its own exclusive "convection stack" which permits compact installation with cool operation.

But that's not all. There's more magic in these E-M Motors:

GREATER OPERATOR COMFORT. No more hot blasts at face level. Since heated air from the top discharge rises straight to the ceiling, the usual warm air buildup at operator level is eliminated.

QUIET OPERATION. Aerodynamically sloped stator blowers and labyrinth air passages are among the

For more facts circle 218 on Reader Service card, p 101

2300 volts. O. W. Johnson, plant superintendent, and C. H. White, assistant plant superintendent, are discussing advantages of straight-up ventilation of machine at left. Air-flow is indicated by paper streamers temporarily attached to discharge louver.

You a Compact Installation!

acoustical control features which help to minimize windage noise. The motor is not dead silent . . . just remarkably hushed.

EASY MAINTENANCE. Access panels and bearing caps are easily removed by one man without use of crane or lifting device. Permits quick inspection of coils, stator core, bearings.

And, of course, you still get the same premium materials and hand-crafted construction that has made E-M quality famous for over 60 years.

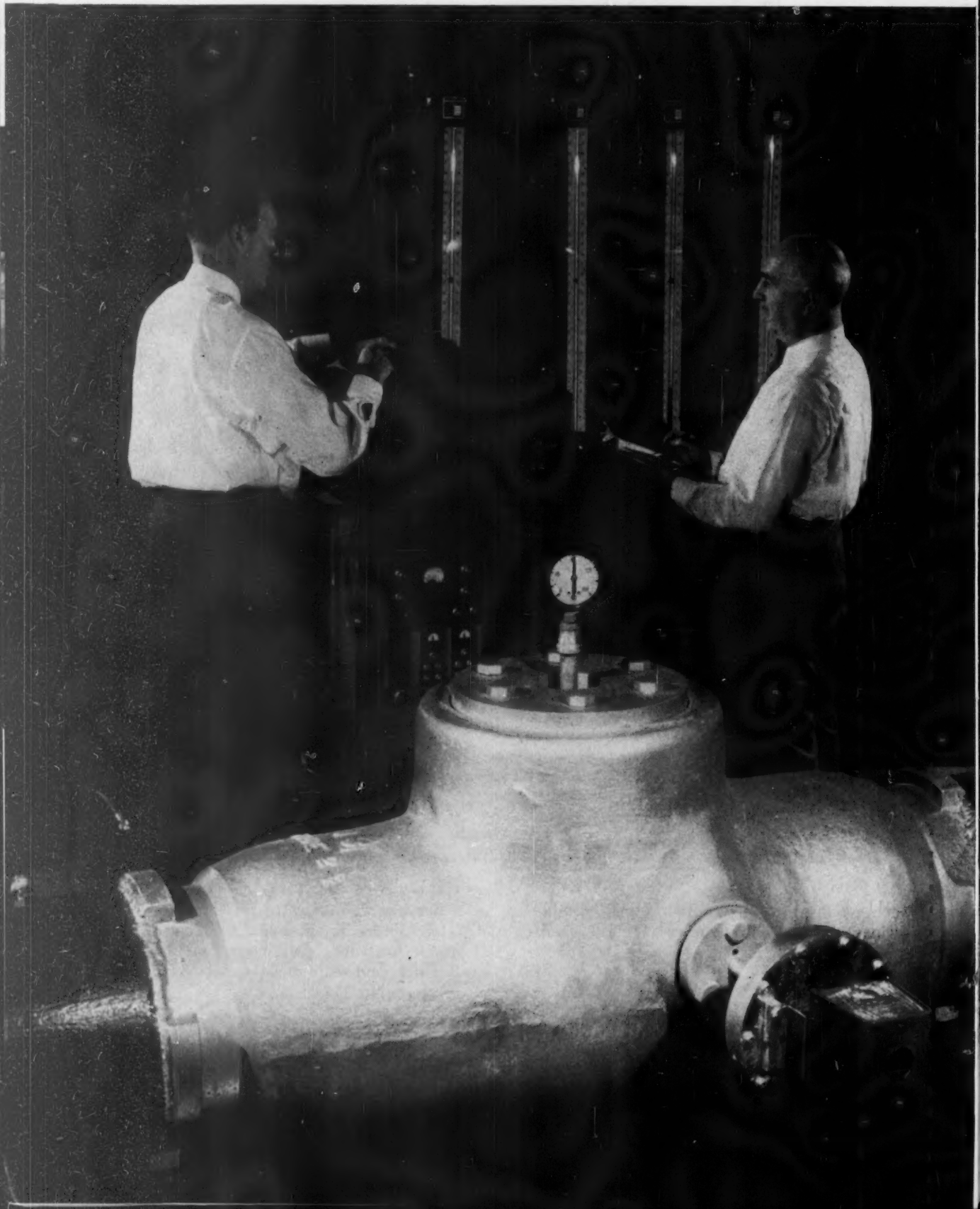
See how the magic of E-M Straight-Up-Ventilated Motors can solve *your* boiler feedwater pump power problems. Call your nearby E-M Field Engineer and write to the factory for your copy of brochure No. 1134.

ELECTRIC MACHINERY MFG. COMPANY
Minneapolis 13,
Minnesota

1300-TPA-2210

Circle 219 on Reader Service card, p 101 for following ad ➤

The Story of Edward Research



and the Foolproof Check Valve

The design of the Edward tilting disk check valve started with a single objective: one-piece body construction. Edward designers were convinced that they could achieve this essential objective and, at the same time, assure ease of inspection and maintenance after the valve was welded in the line. Ideally, the valve also had to have these four important operating features: 1) Tight seating; 2) Non-stick operation; 3) Quiet, slamless closing; 4) Low pressure drop. Six years of research and testing gave them these desired features, and made possible this Edward success story.

ONE-PIECE CONSTRUCTION

Both manufacturing and engineering considerations indicated the wisdom of a design with the seat at a right angle to the pipe line. It was also essential that gravity close the disk, whether the pipe was in a horizontal or vertical position. Edward engineers solved this dual problem by welding a counterweight to the disk so that the force of gravity would pull the disk down tight on the seat whether the valve was installed horizontally or vertically. With this new disk idea, the valve seat could be formed of a single circular weld deposit of Stellite, and could be machined and finished through the end of the valve. The resultant one-piece body is virtually impervious to leakage or distortion.

TIGHT SEATING

Getting the disk to seat tightly was especially important because even a small amount of reverse flow was a hazard to pumps and compressors. Edward designers, after experimenting with several pivot positions, pivoted the disk half-way between its center and the upper seating surface. The tapered Stellite-faced disk closes on a tapered Stellite seat in the manner of a globe stop valve. When flow reverses, the larger lower portion of the disk swings downstream while the smaller upper portion swings upstream. Utilizing both gravity and the force of reverse flow, perfect alignment and tight seating are achieved.

SLAMLESS, NON-STICK OPERATION

The unique Edward water flow test loop with its 2,000,000 lb per hour capacity closely simulates actual service conditions. Edward researchers could observe the effects of vibration and water hammer at all stages of tilting disk development. Designing the valve to close quickly—before reverse velocity could build up—virtually eliminated slamming and vibration. Three features make this possible.

First, the disk is dome-shaped to avoid the hesitation of motion characteristic of flat disks. Second, disk travel is minimized by pivoting the disk in the flow stream. Finally, torsion springs enclosed in the pivot pins accelerate closing action from the full-open position. The valve closes efficiently and achieves maximum opening even at lowest flow rates.

LOW PRESSURE DROP

Minimum flow resistance was achieved through painstaking design of all surfaces in the flow line. Full port seat design plus streamlined disk and location of the counterweight out of the flow stream resulted in minimum pressure drop.

A FOOLPROOF VALVE

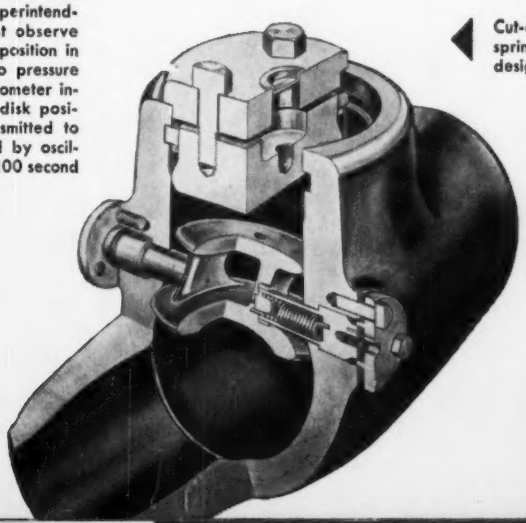
By tackling each problem separately—but always in relation to the entire design—Edward researchers came up with a tilting disk check valve that operated like no other check valve. It was dependable because it always functioned, effective because of its tight seating and low pressure drop, unique because it greatly minimized slamming, vibration, and water hammer.

This is the same tilting disk check valve, developed and patented by Edward Valves, that is so widely used in today's conventional, supercritical and nuclear power stations. Edward Catalog 14-Y gives full details.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for power, industrial, marine, and petroleum services. For more information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal. 6023

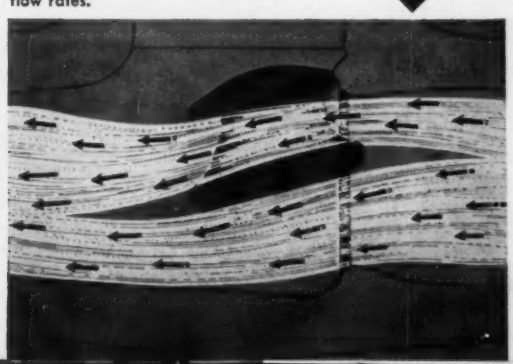
EDWARD STEEL VALVES
another fine product by
ROCKWELL

Director of Engineering and Research L. H. Carr and Plant Superintendent R. E. Rost observe test for disk position in relationship to pressure surge. Potentiometer indications of disk position are transmitted to and recorded by oscillograph in 1/100 second intervals.



Cut-away view of Edward tilting disk check valve shows torsion springs enclosed in pivot pins, pressure seal cover and other design features.

In the open position the disk rests against a stop, thus minimizing disk flutter. Careful design of disk facilitates maximum opening, even at extremely low flow rates.



Please don't feed the "TUBE EATERS"

Don't let unnecessary pitting, cracking or erosion chew up tubes before their time. Don't let *any* type of corrosion, scale or biofouling hamper your heat exchange efficiency without checking these four factors:

• Is the tube alloy *right?* Will a vital difference in corrosion resistance result from a minor alloy change—or is an entirely different alloy called for? • How much will performance be improved by Duplex bi-metallic tubes which provide the best metal or alloy for *each* heat transfer medium. • Will a change to thickened-end or thickened-center tubes give needed extra resistance where attack is most severe? • What actual data on similar exchanger operations are available?

We at Bridgeport can help you. Our condenser tube experience dates back to 1900 but our files are completely up-to-date on tube problems reflecting the high pressures, temperatures and velocities of modern operations. Write Bridgeport Brass Company, Bridgeport 2, Connecticut.

Bridgeport condenser and heat exchanger tubes in over 50 metals and alloys:

INHIBITED ADMIRALTY
INHIBITED ALUMINUM BRASS
INHIBITED MUNTZ METAL
70-30 CUPRO NICKEL
90-10 CUPRO NICKEL
DEOXIDIZED ARSENICAL COPPER
INHIBITED ALUMINUM BRONZE
RED BRASS
ALLOY 77 MERCURY BRASS

...plus **DUPLEX TUBES**...in combinations of the above alloys, with carbon or stainless steel, aluminum, Monel,® nickel...or other metals.

BRIDGEPORT BRASS COMPANY

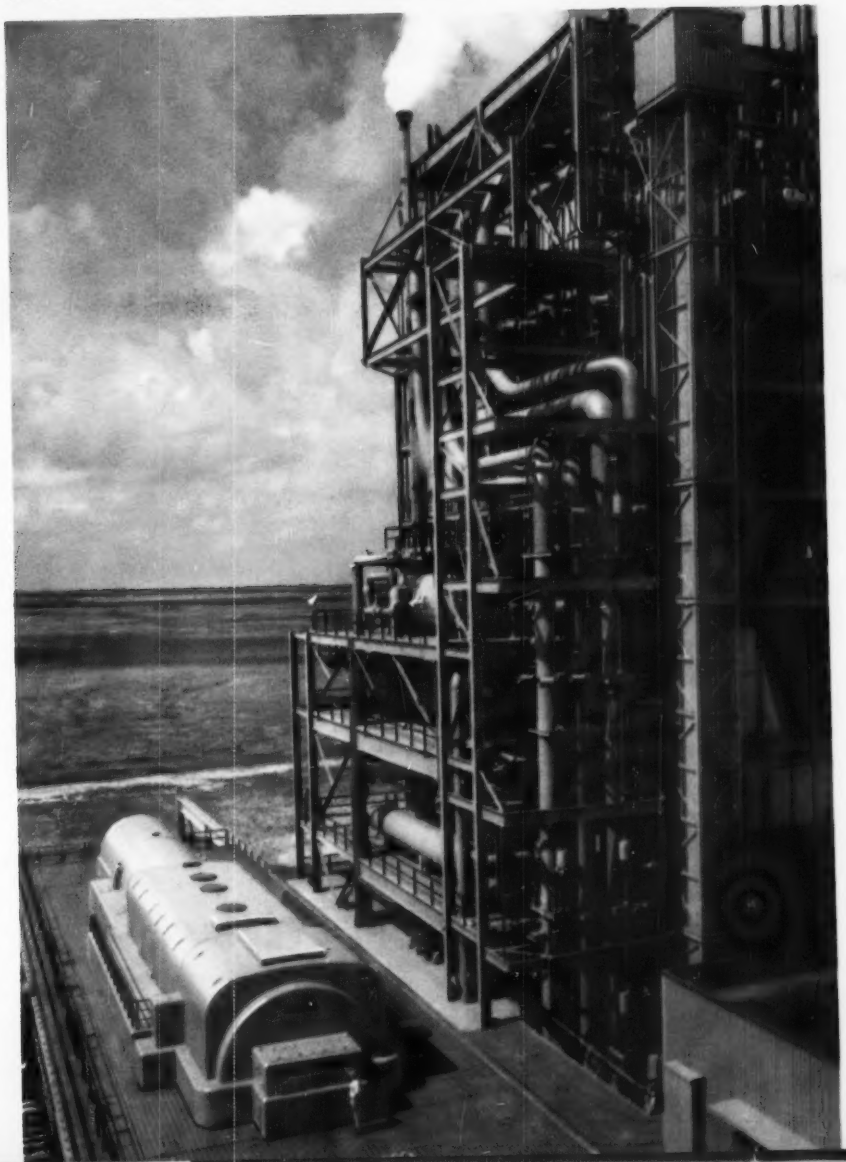
Bridgeport

For more facts circle 220 on Reader Service card, p 101

Circle 356 on Reader Service card for following ad ➤

NEW

INSTALLATION TECHNIQUES MAKE ALL OTHERS OBSOLETE



ALLIS-CHALMERS

A-1492

Pre-installed piping systems and precision optical tooling cut man-hour expenditures as much as 34 percent

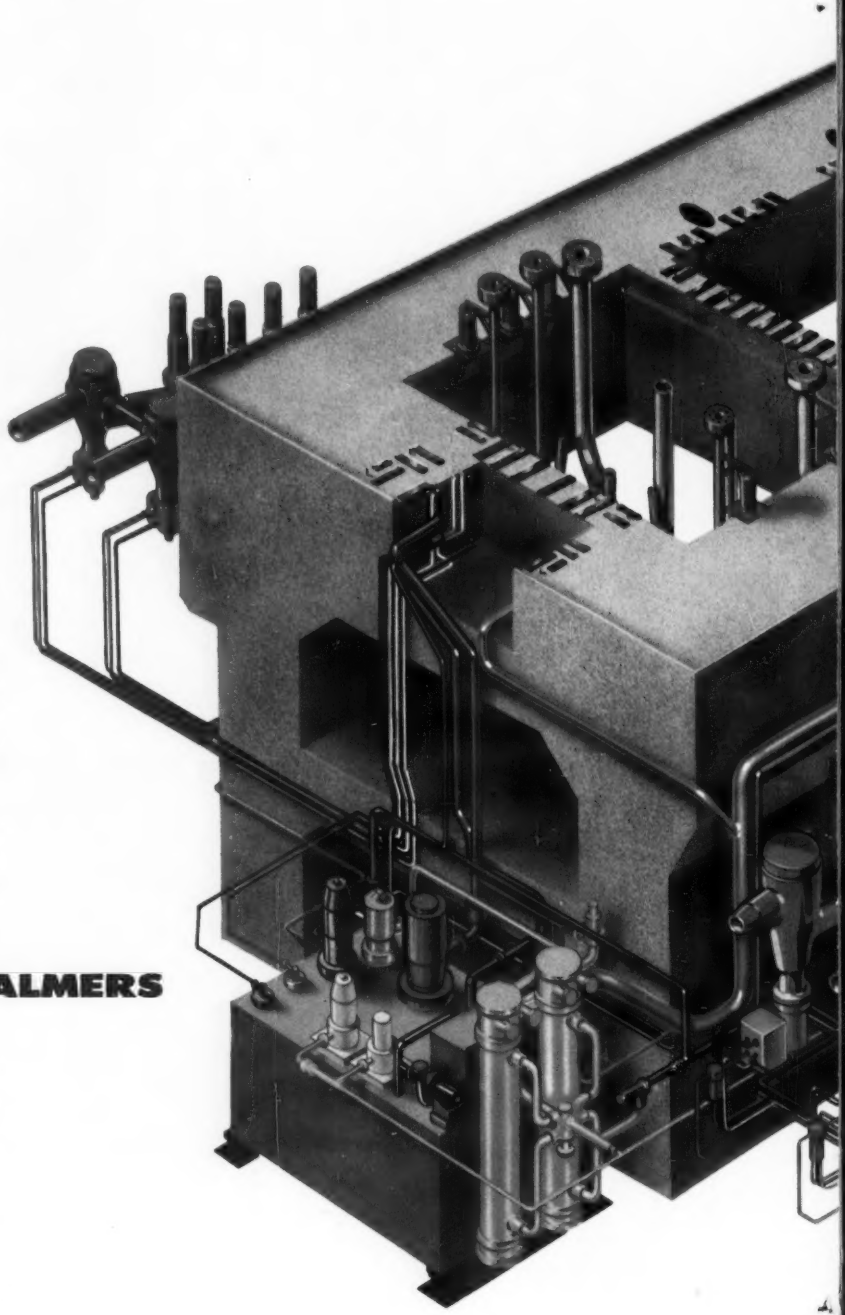
Exclusive A-C tools and techniques reduce turbine-generator installation costs — permit faster, ultra-accurate unit assembly — establish new power industry standards.

For example, a 220-mw tandem triple-flow unit (see bar chart) was recently installed in 25,000 man-hours with new A-C techniques — against 38,000 man-hours required with other methods. And this machine was placed on the line without a shutdown between first steam admission and attainment of maximum load — dramatic proof of the effectiveness of the advanced Allis-Chalmers methods. Equivalent results, unmatched in the industry, are being recorded with other large A-C units!

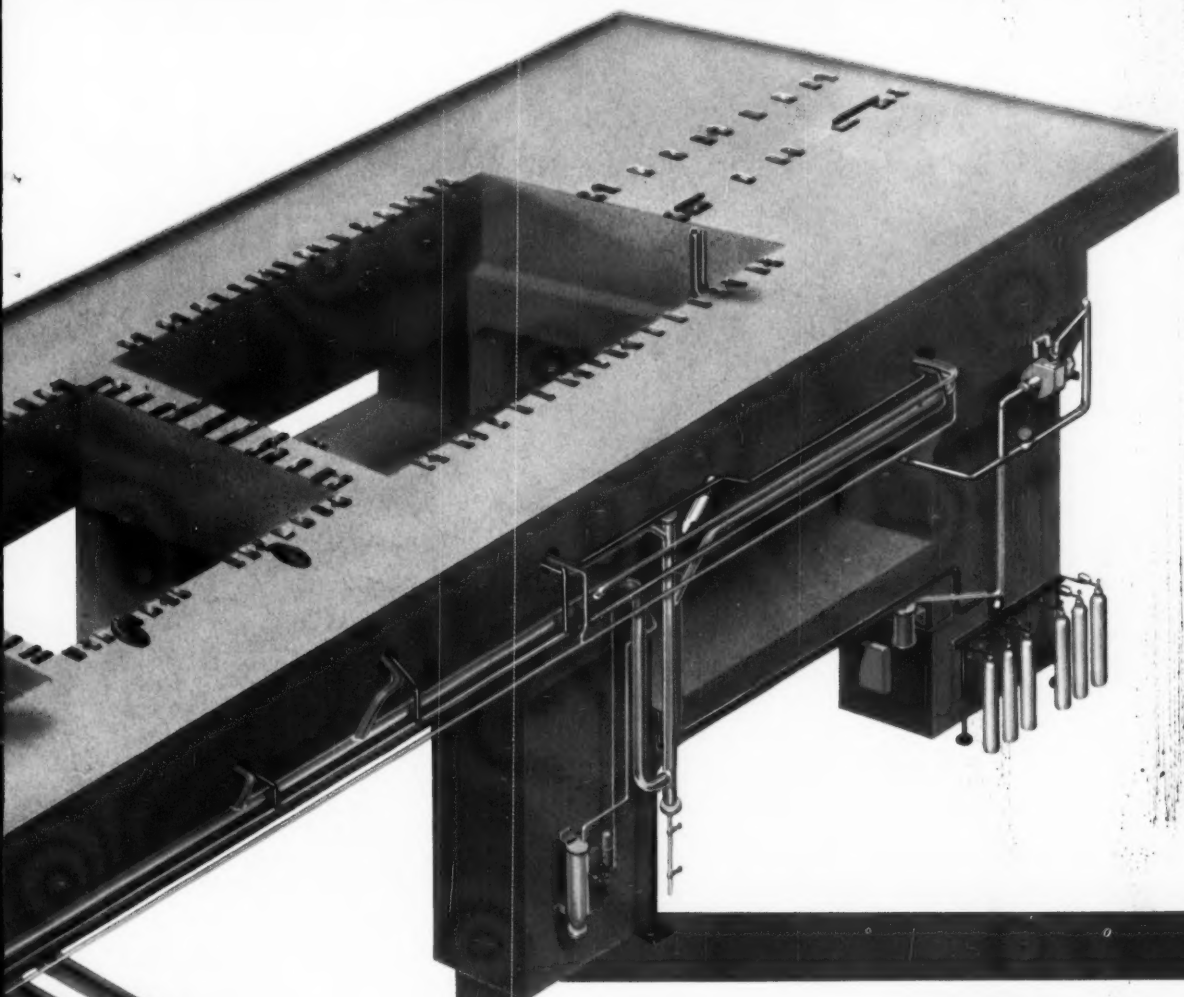
Factory-field coordination, based on modern turbine-generator assembly and testing facilities, translates components from test pit to foundation with absolute precision and man-hour reduction.

Advances such as these stem from Allis-Chalmers vast experience and forward-thinking engineering. They help electric utilities meet the economic and scientific challenges of tomorrow.

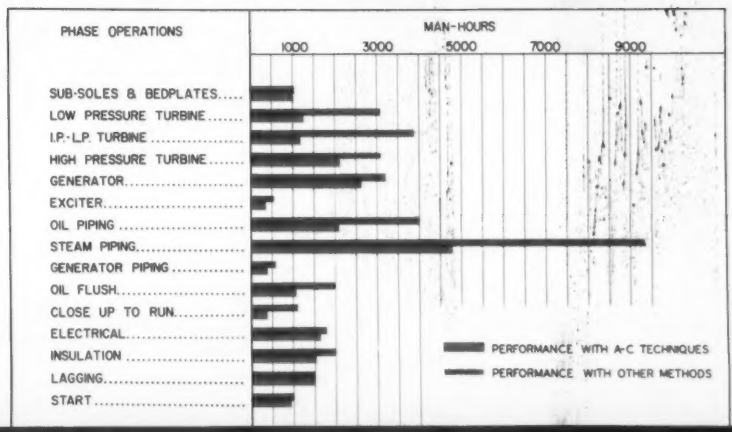
ALLIS-CHALMERS



Pre-Installation of All Below-Floor Pipe and Equipment is completed prior to placing of main unit components on foundation plates. This technique saves thousands of man-hours — assures highest degree of cleanliness and quality for piping and closure welds. Complete oil tank assembly and piping, steam chest, reheat valves and piping, generator coolant and scavenging piping systems are installed with better control . . . also, less interference because fewer men are present; the work area more accessible.



At the Pre-Installation Conference, A-C engineers meet with utility, consulting and contractor personnel to discuss the installation program and plan man-hour estimates. Installation procedures (below in bar-chart) are reviewed to determine necessary manpower, tools and facilities required at various stages of progress.



PROCEDURES COORDINATED BY UNIFIED SUPERVISION

minimize installation time . . . assure ultra-accuracy . . . simultaneously!

Installation Responsibility Under One Superintendent unifies job supervision — uniquely covers existing A-C equipment at the power station as well as new turbine-generator and additional A-C products. Central responsibility assures close control of installation procedures — permits prompt job-site decisions.

Special Centerline Telescope permits quick alignment of major turbine components. During manufacture this precision instrument determines final relative position for each pedestal bearing bore. At the job site, the telescope re-establishes this centerline for accurate turbine assembly with all clearances as determined at the factory. Field measurement of internal clearances is eliminated and installation of components, including those shipped with spindles in position, is accomplished faster and more accurately.

☆ ☆ ☆

For Bulletin 03B9997, *which gives you further information about Allis-Chalmers advanced installation techniques, ask your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.*

With Precision Optical Leveling Equipment, field installation of Allis-Chalmers turbine-generator units is little more than a reassembly operation. Savings to you . . . over 8,000 man-hours for a tandem triple-flow machine; similar reductions for other types and ratings. This special tooling permits simultaneous establishment of horizontal reference planes on the test pit (top) and on the foundation (bottom). All factory-recorded clearance and reference data plus assembly shim packs are translated from level plane to level plane. *Result: precise unit alignment and assembly with no time-consuming "cut and try" operations or delaying field adjustments.*

ALLIS-CHALMERS PACING POWER PROGRESS

VERTICAL DESIGN

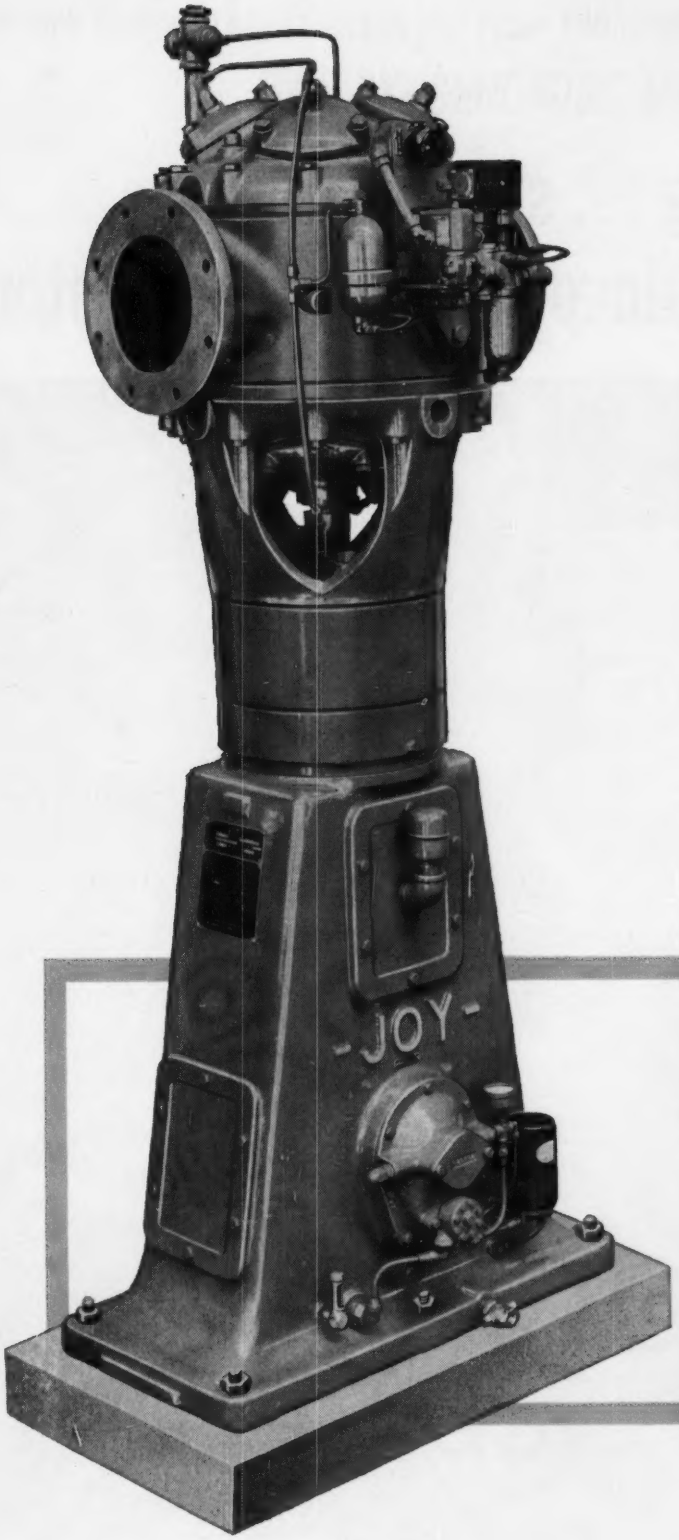
gives you oil-free air
with low maintenance

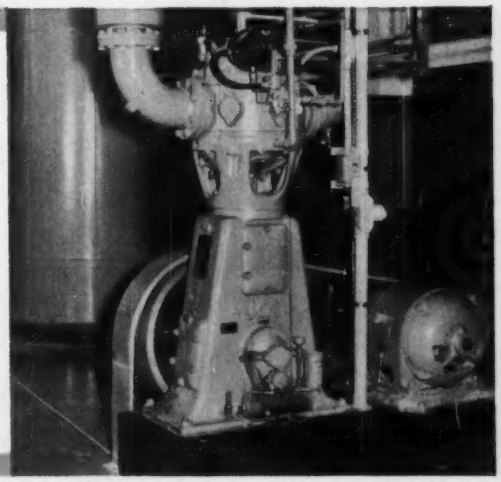
JOY WGO-9 Compressors

Because the Joy WGO-9 oil-free compressor is designed vertically, carbon ring wear is greatly reduced. Equal pressure on all sides of the piston rings produces even wear and reduced maintenance. The piston need never be rotated.

All Joy oil-free compressors are equipped with carbon graphite piston rings of an exclusive T-block design. They require no lubrication and compensate automatically for wear so that blow-by is virtually eliminated for the life of the ring. Joy compressor owners report ring life of 8000 operating hours or more.

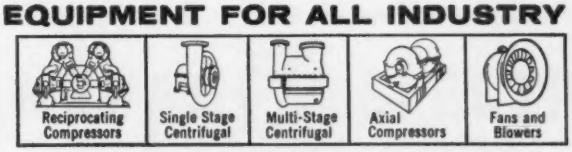
WGO-9 compressors are available from 95 to 1528 cfm, 15 to 150 hp. Joy also builds complete lines of larger oil-free units including centrifugal and axial types as large as 15,000 hp. For complete information on the WGO-9 write for bulletin 2415-16.





This WGO-9 supplies oil-free air for instruments and controls at a large central station powerhouse of a mid-western utility.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



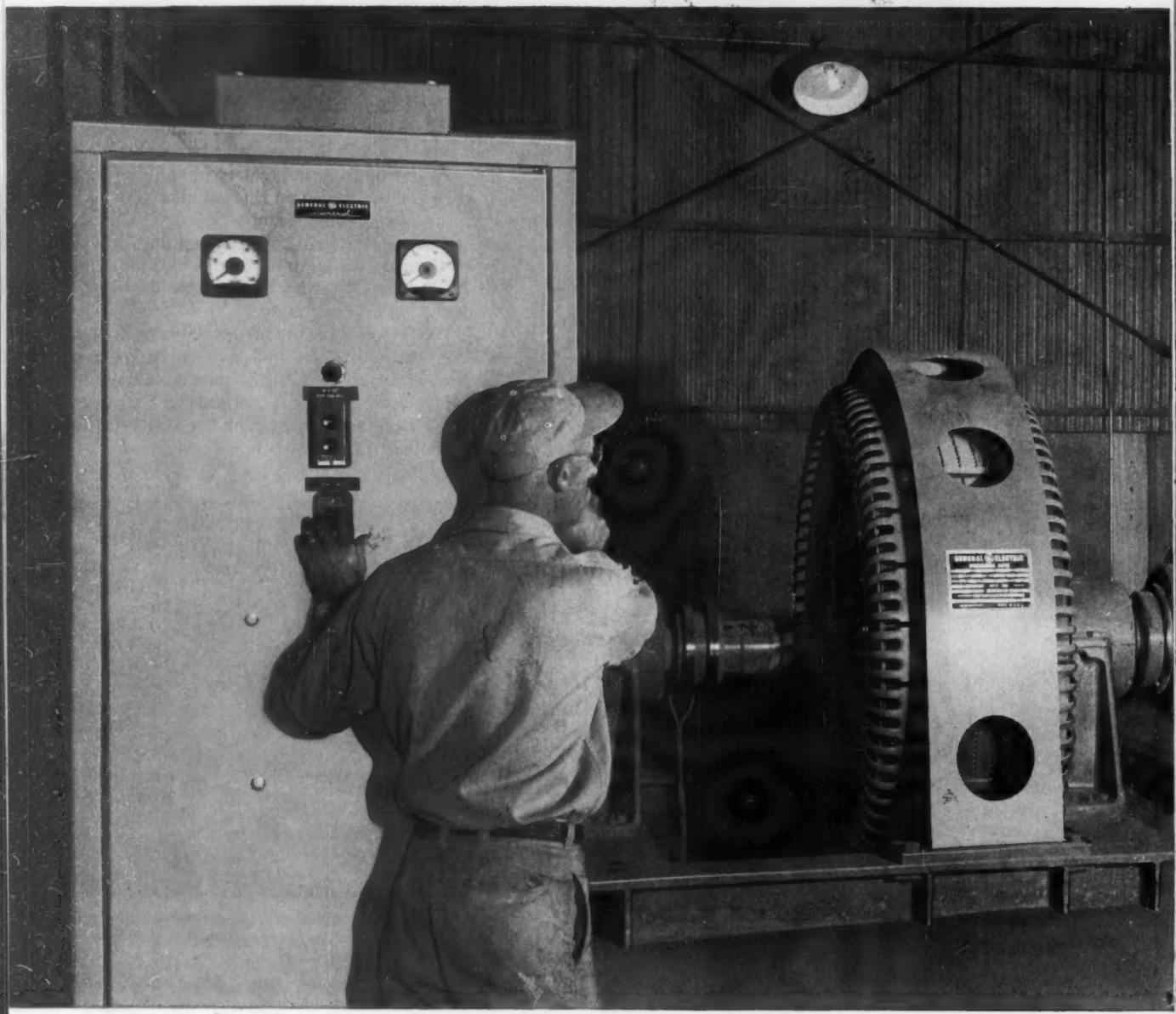
JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more facts circle 221 on Reader Service card, p 101

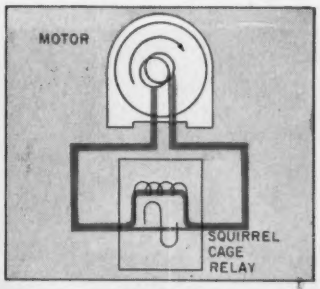
Start-up . . . running . . . shutdown . . . Only General Electric offers full-time motor



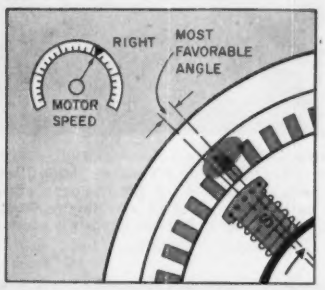
LOW- AND HIGH-VOLTAGE STARTERS FOR PUMP AND COMPRESSOR MOTORS

SYNCHRONOUS MOTOR CONTROLS

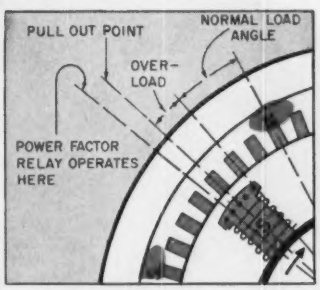
protection, maximum power use



At low speed, SCR heater "sees" current proportional to that in winding. As speed increases, current is proportionally shunted around heater, giving protection at all speeds.



When motor speed and load angle are correct, field-application relay applies field excitation; synchronizes motor under most favorable condition.



Power-factor relay monitors angle between rotor and stator poles. As rotor starts to slip, angle causes the flux to stretch. Relay removes field within first half-slip-cycle.

At start-up . . . while running . . . at shutdown . . . General Electric synchronous motor controls safeguard equipment from "burnout" and permit full-time use of *all* the power capability of your motors. Only General Electric offers a control precisely combining all key factors in top synchronous performance:

GRADUATED SQUIRREL-CAGE PROTECTION results from the use of an ambient-compensated thermal relay placed in the field-discharge circuit. This thermal relay monitors the temperature of the squirrel-cage winding . . . constantly protecting the motor from overheating at all speeds, and allowing it to operate safely under all starting conditions.

PRECISION-ANGLE SWITCHING applies field excitation at exactly the right moment to take full advantage of the motor's pull-in torque. The result: synchronization on the first attempt! This means maximum use of power, without repeated attempts to pull in, excessive motor stress, and other harmful effects.

SPLIT-SECOND FIELD REMOVAL system cuts off excitation immediately—within the first half-slip-cycle—in case of excessive load torque, line or excitation-voltage fluctuations. Thus, damage to motor pulling out-of-step is virtually eliminated.

Get full value from the next motor you buy . . . start, run, and protect it with a versatile General Electric Synchronous Control. Call your G-E Sales Representative. Or, write Section 783-21, General Electric Co., Schenectady, N. Y., for Bulletin GEA-5873. *Industry Control Dept., Salem, Va.*

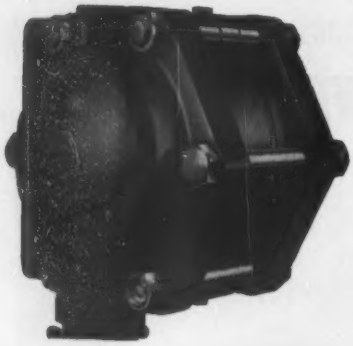
SYNCHRONOUS MOTOR FIELD CONTROL

	General Electric	Company "A"	Company "B"
Graduated Squirrel-cage protection	Allows maximum motor utilization and protection at all speeds.	Prohibits maximum utilization of motor.	Satisfactory, but lacks precision.
Precision-timed field application	Selects both speed and most favorable rotor angle. Synchronizes on first attempt.	Avoids most favorable angle. Dissipates synchronizing ability of motor.	System lacks precision in finding favorable angle.
"Split-second" field removal	Field excitation is completely removed within the first ½ slip-cycle.	Motor speed must drop significantly before field is removed. Requires several slip-cycles.	Slip may be as high as 6% before field is removed. Does not assure protection.

Progress Is Our Most Important Product

GENERAL ELECTRIC

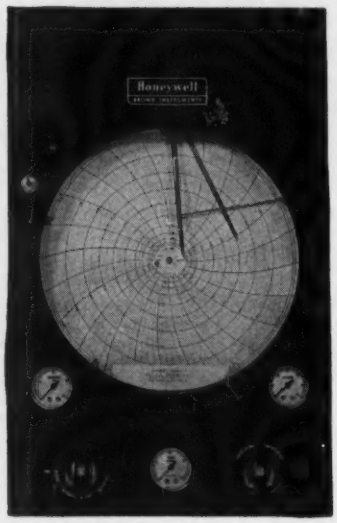
For more facts circle 222 on Reader Service card, p 101



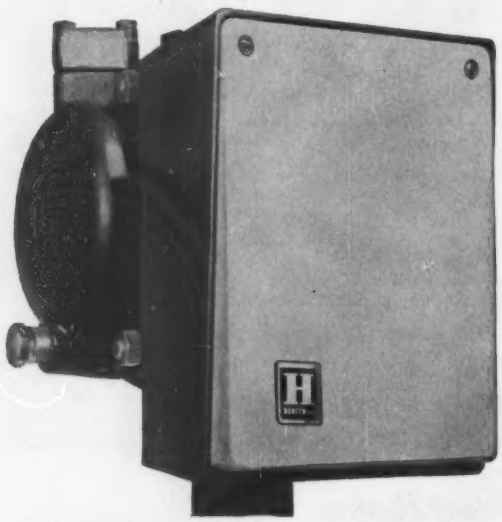
Honeywell Bellows Meter brings

Six of many ways you can use the bellows meter

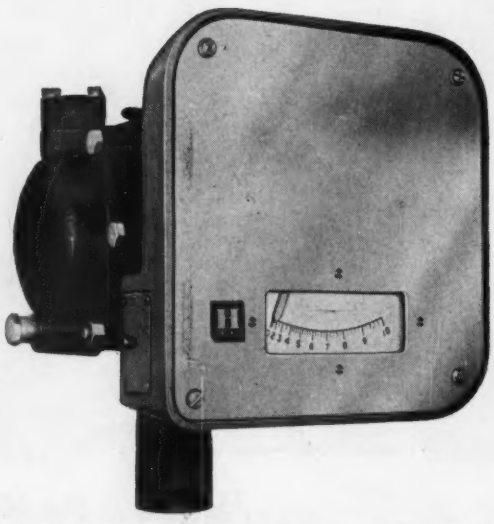
As a Recorder or Integrator—Recorders can have one, two or three pens, with the second and third pens actuated by thermometer or pressure elements. A single-pen recorder is shown above. You can get integration, too.
Write for Specification S 292-2a.



As Recording Controllers—You can get recorders with pneumatic ON-OFF, 10% *Throttlor*, 150% *Throttlor* with manual reset, or *Air-O-Line* (150% proportional band-plus-automatic reset) control. A single-pen pneumatic controller with integral bypass is shown above.
Write for Specification S 292-2a.

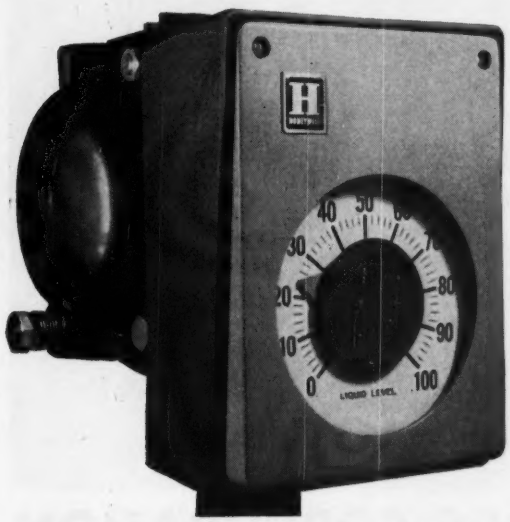


As a Non-indicating Pneumatic Transmitter—Use this non-indicating transmitter when you don't need indication at the point of measurement, and when the measured variable is to be transmitted to remotely located instruments.
Write for Specification S 230-1.



As an Electric Transmitter—You can use this *ElectriK Tel-O-Set* electric flow and liquid level transmitter with indicators, recorders, and controllers, with data handling systems, or with millivolt receivers. Field indication, as shown, is optionally available.
Write for Specification FS 301-7.

new versatility to flow or liquid level measurement



As an Indicating Pneumatic Transmitter—Gives you indication at the point of measurement, plus pneumatic transmission. Easy-to-read scale, and large indicating pointer. Case is only 4 by 7 by 9 inches.
Write for Specification S 230-1.

As a Dial Indicator—Six-inch dial indicator gives easy, accurate readings at point of measurement. This meter-indicator is designed specifically for field indication.
Write for Specification S 224-1.

You can use the Honeywell Bellows Flow Meter as a recorder, controller, indicator or transmitter . . . pneumatic or electric. Use it for accurate, low-maintenance metering of flow—for steam, water, gas, oil or other fluids—or for liquid level measurement. In all of its many forms, with all of its performance advantages and operating economy, it is the most advanced flow and liquid level meter available today.

Some outstanding features:

Stability—The meter body will operate over an ambient temperature range of —40° to 250°F. Over a range from —32° to 150°F. the accuracy will not change more than 0.5%.

Leakproof construction—Hydraulically formed stainless steel bellows eliminate any chance of leakage between fill and process fluid.

Quick, easy damping—Rectangular orifice pulsation check varies the speed of response over a ratio of 20 to 1. Adjustment is essentially linear and can be made from outside the meter body while the instrument is operating.

Sensitivity and accuracy are well within the required limits of measurement and control on applications for which these instruments were designed.

Convenience—Change range easily in the field by replacing a single range spring assembly. The meter body is self-venting when measuring liquids and installed below the flow line; self-draining when measuring gas and installed above the flow line.

There are models of the Honeywell Bellows Flow Meter available in many ranges, for every application. Your nearby Honeywell field engineer can give you complete details and help you select the correct model for your application. Call him today.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

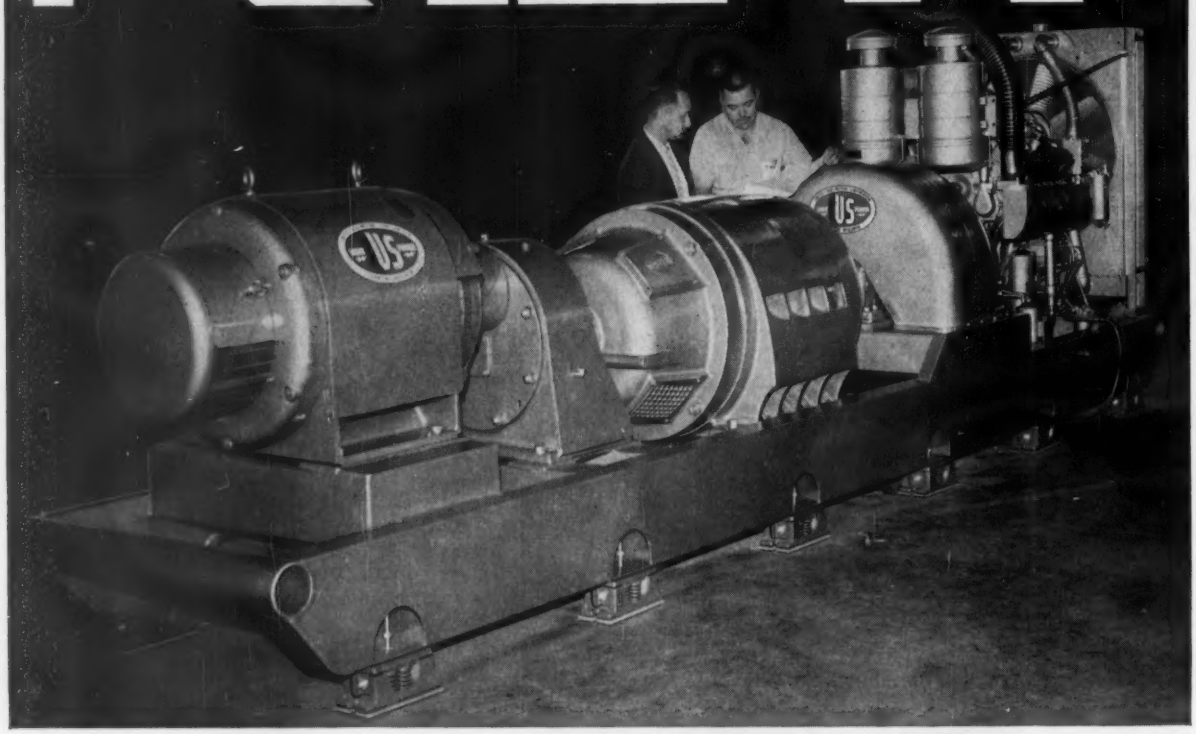
Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

NEW



BY UNITED STATES MOTORS CORPORATION

100 KW DIESEL "MICRO POWER"

A COMPLETELY NEW DIMENSION IN NO-BREAK UN-INTERRUPTED ELECTRIC POWER SUPPLY

United States Motors Corporation is keeping pace with the industry — growing daily. In days past, our Micro Power units ranged in size from 1½ KW to 20 KW capacity. Today, we are building Micro Power units in capacities up to the NEW 100 KW UNIT pictured above. Tomorrow — we will build them even larger to satisfy the increasing capacity requirements for dependable no-droop, no-drop standby power. Every Micro Power built today reflects more than 10 years of laboratory and field research-testing. What's more — several thousand operating units attest to its demand for a wide variety of applications.

SPECIALIZED SALES AND SERVICE CENTERS LOCATED THROUGHOUT THE UNITED STATES & FOREIGN COUNTRIES

For complete information — call or write

SPECIAL FEATURES

- ★ off the line initial start-up with automatic engine control.
- ★ load isolation from incoming supply at all times.
- ★ incoming 50 cycle frequency automatically converted to 60 cycle output frequency when desired.
- ★ ultimate for stabilizing incoming variations of voltage and frequency.

MICRO US POWER

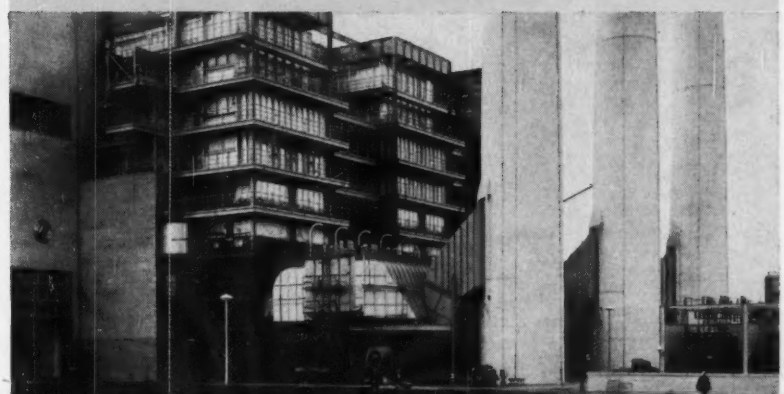
UNITED STATES MOTORS CORPORATION 102 West Fifth Avenue • Oshkosh • Wisconsin

For more facts circle 224 on Reader Service card, p 101

Circle 225 on Reader Service card for this ad ➤

Multiclones remove soot at Los Angeles steam power plant

Oil burners in California... and coal burners in New Jersey...agree:



Electrostatic Precipitators catch fly ash at Sewaren steam power plant

When DUST is your problem— CLEAR IT WITH WP*

For an efficient, economical solution to any dust control problem—look to Western Precipitation. WP is uniquely fitted to handle your unique problem—being the one organization that custom designs, engineers and installs ALL types of dust and fume control equipment: Precipitator, Mechanical, Jet-Cleaned Filter, Hi-Temp Filter, scrubbers and engineered combinations.

With no axes to grind for any one system, WP engineers will give your job a completely unbiased recommendation—whether it's a quote on your specifications, a single component, or a completely engineered installation... small, major, simple, or complex.

An inquiry—on your business letterhead—will bring you literature promptly. Just write Western Precipitation, 1000 W. 9th St., Los Angeles 54, Calif. (In Canada, write 8285 Mountain Sights Ave., Montreal, P.Q.)

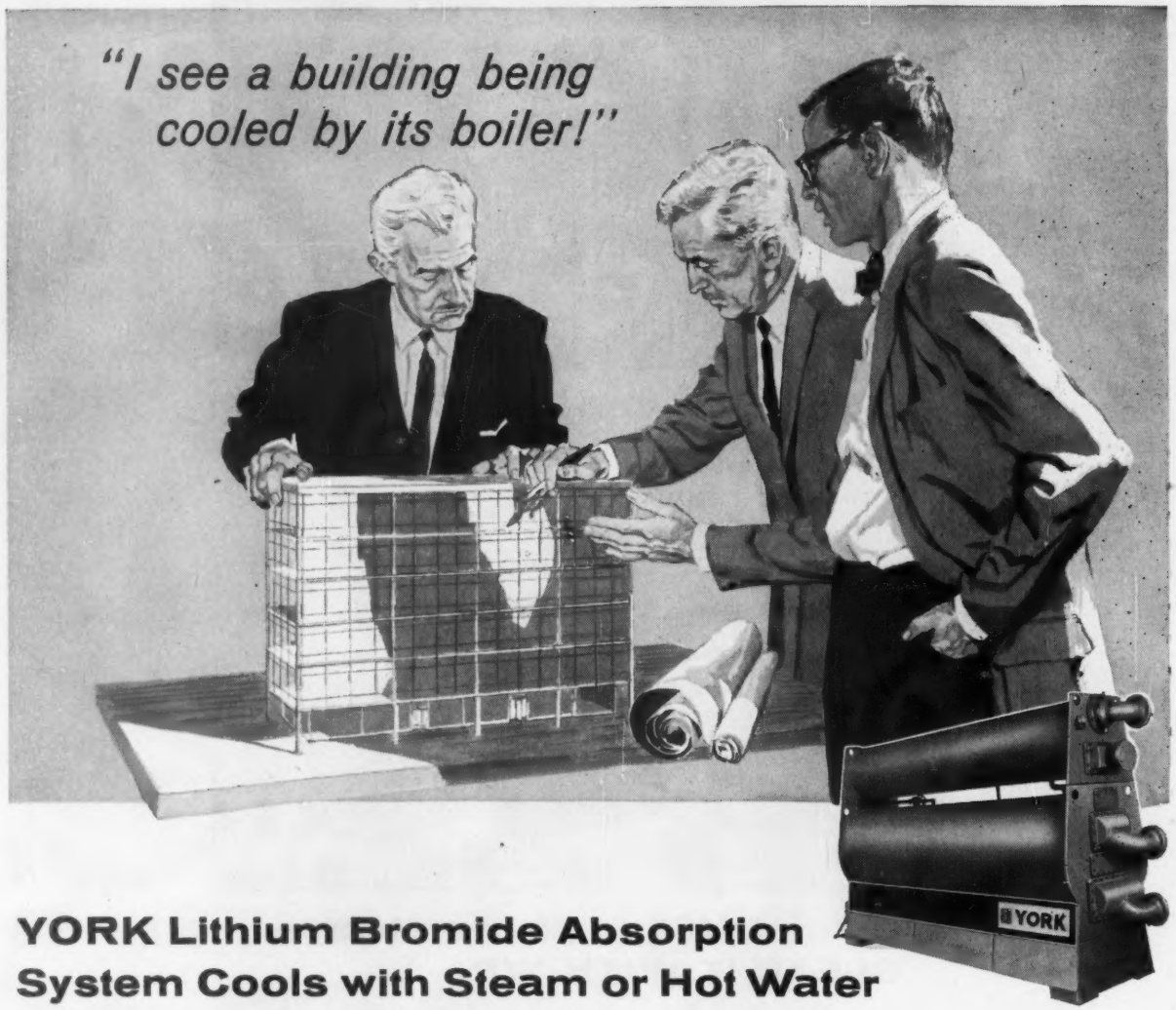
Dust and fume control since 1907

*WESTERN PRECIPITATION

Los Angeles 54 • New York 7 • Chicago 2 • Pittsburgh 22 • Atlanta 5 • San Francisco 4

Division of Joy Manufacturing Company

ELECTROSTATIC Precipitators
MULTICLONE Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi Temp Filters
TURBULAIRE Scrubbers
JOY-MICRODYNE Scrubbers
also: **HOLO-FLITE** Processors
HI-TURBIANT Heaters
TURBULEX Calciners



YORK Lithium Bromide Absorption System Cools with Steam or Hot Water

Uses less pump HP per ton of refrigeration

CAN UTILIZE EXCESS BOILER CAPACITY—Unique system uses existing steam or hot water. Refrigerant is plain water, absorbent is lithium bromide. This plus low pump horsepower spells lower operating costs...lower electrical installation.

MINIMUM FIELD WORK—Control center, including all system pump motor starters, controls and system pumps are factory-wired. And York's capacity-control system simplifies field piping by eliminating need for by-pass lines.

LOWER INSTALLATION COST—No expensive starters or heavy electrical conduit. Noiseless, vibration-free operation permits installation anywhere from basement to roof without costly foundations. Roof-top location saves piping and pipe shafts.

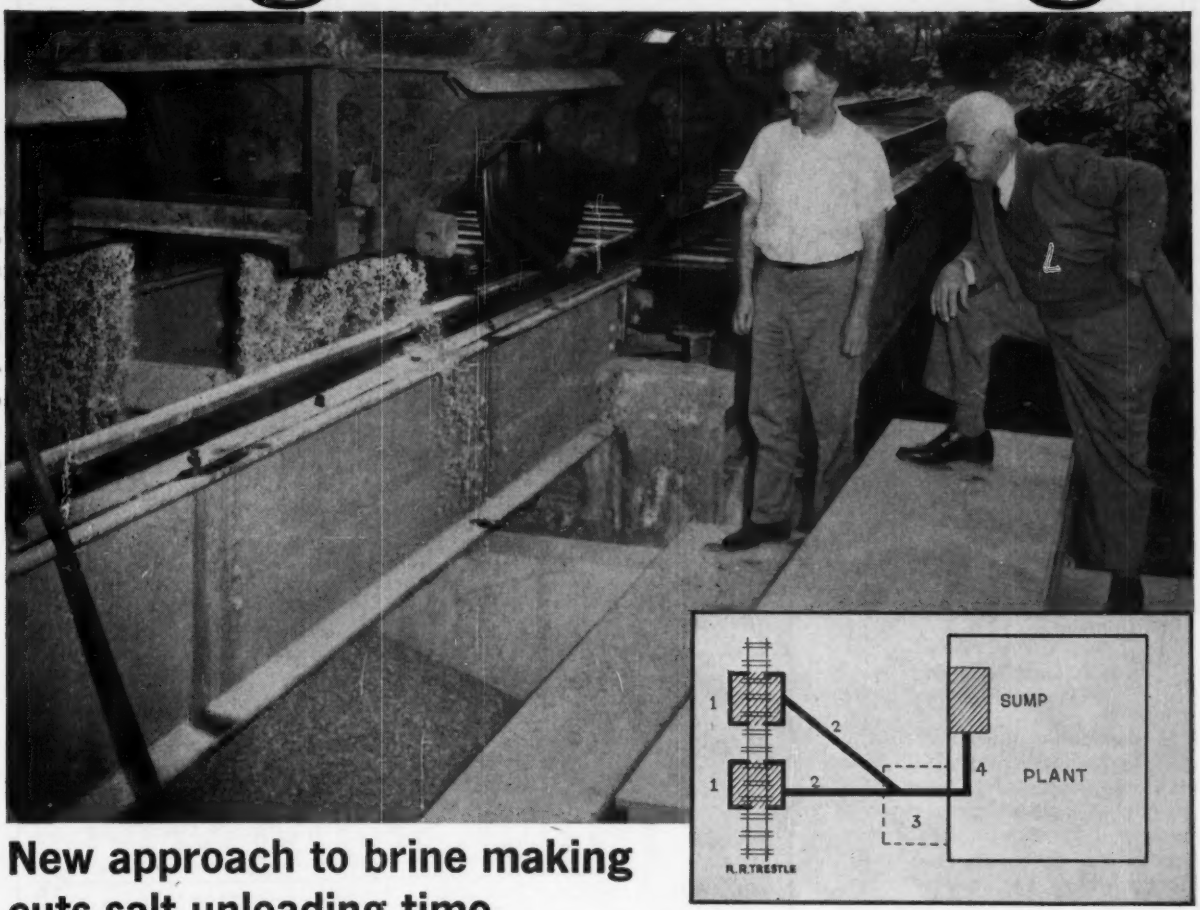
VIRTUALLY MAINTENANCE-FREE—Except for 3 small pumps and motors, the unit has no moving parts. Operates automatically, easily handles load changes. Steam valve provides simple, direct capacity control 50 to 1000 tons refrigeration.

Another YORK Trail Blazer Concept Proved in Action at *Allen Mfg. Co., Bloomfield, Conn.*—Excess boiler capacity in summer is used to deliver very economical cooling. A 230-ton York Absorption System air conditions the office and cafeteria, and a 170-ton unit chills process water.

YORK CORPORATION
Subsidiary of Borg-Warner Corp.
YORK, PENNSYLVANIA
2907 SOUTH GRANTLEY ROAD, YORK, PENNSYLVANIA

Air Conditioning, Heating, Refrigeration and Ice-Making Equipment • Products for Home, Commercial and Industrial Applications

salt engineering



Pipes (2) deliver brine from new 55-ton Lixators (1) to existing pipe line (4) that served old Lixator (3). New construction made maximum use of existing installation—did not affect railroad trestle or plant interior.

New approach to brine making cuts salt unloading time 32 man-hours per car

At this N. J. plant Sterling Rock Salt used to be unloaded manually into a chute feeding a brine tank located ten feet from the tracks. Cost of the operation: an expensive 32 man-hours per car. Furthermore, the 60-ton brine tank had to be exhausted down to ten tons before another 50-ton carload of salt could be added, creating problems of reserve and scheduling.

An International Salt Company Technical Service representative and the plant manager solved the situation by installing two 55-ton Sterling Storage Lixators under the existing railroad trestle. Salt drops directly from the hopper cars into them. Gravity supplies the labor, releasing the 32 man-hours. And when the Lixators* get down to 30 tons each, a 50-ton carload tops them off with 25 tons apiece. Ordering is simplified, and the buyer never has to worry about reserve. And how does the salt get to points of use? Simple. The Lixators produce crystal-clear, fully saturated brine *automatically*. Pipes carry it into the plant.

Local contractors competed for the job by sealed bids estimated from complete plans supervised by International's Technical Service Department.

This project is a good example of how International salt engineering can benefit salt users. If you're interested in unequaled technical assistance on any phase of salt handling, storage or dissolving, write International Salt Company, Clarks Summit, Pa., or nearest district office.

*Registered T.M. International Salt Company

BOSTON CHARLOTTE CINCINNATI NEWARK NEW YORK PITTSBURGH
BUFFALO CHICAGO DETROIT NEW ORLEANS PHILADELPHIA ST. LOUIS

INTERNATIONAL STERLING SALT SALT COMPANY

"A STEP AHEAD IN SALT TECHNOLOGY"

For more facts circle 227 on Reader Service card, p 101

Why Every Steam Heated Unit Needs its Own Steam Trap

. . . the theory, practice and proof of "unit trapping" for top temperatures

Using an individual trap for each steam heated unit, including each separate coil, chest or chamber of a machine—pays off for the user. Here are just two examples:

1. On a creamery dryer

Drainage Method	*Air Temperature*
Restricted Blow-thru	250°
Group trapping (1 trap for 8 coils)	225°
Armstrong Unit Trapping (8 traps—1 for each coil)	**309°**

2. On a platen press

Drainage Method	*Processing Time*
Restricted Blow-thru	50 minutes
Group Trapping	35 minutes
Armstrong Unit Trapping	**25 minutes**

Why Unit Trapping Works Best

It is reasonable to assume that no two steam heated units will have *identical* condensing rates. Even the slightest difference in rate will cause a difference in steam pressure drops through the units. Here's where the trouble starts. Condensate from each unit may flow to the trap. But, what about air and other non-condensibles in the system? A difference in pressure drops too small to be indicated by an ordinary pressure gauge will permit backflow of steam from the higher pressure units to the lower pressure units. This backflow of steam may even impede flow of condensate from the lower pressure unit to the trap . . . and it will definitely impede or block off flow of air to the trap. The result is sluggish heating, reduced temperatures, reduced output, fuel waste and increased possibility of corrosion. Figures 1, 2 and 3 diagram the action.

Unit Trapping Not Costly

No engineer wants any more mechanical devices in his plant than are absolutely necessary. But, the moderate additional cost of using two or more small traps, instead of one big one, is saved over and over again in improved efficiency.

If the traps are Armstrong, maintenance is no problem. And users frequently tell us that Armstrong traps outlast others two and three to one.

Steam traps usually represent a fraction of 1% of the cost of the equipment they drain. Does it make good sense to lose 10% or more of equipment capacity to save a few dollars on traps?

Why not test Armstrong unit trapping in your plant. If you are not completely satisfied with the results you can return the traps for a full refund of the purchase price. There is little to lose—lots to gain. Call your local Armstrong Factory Representative or Distributor, or write **Armstrong Machine Works, 8129 Maple St., Three Rivers, Mich.**

ASK FOR the 44-page Steam Trap Book and reprint of article on Unit Trapping.

801ST

ARMSTRONG STEAM TRAPS

How Different Condensing Rates Can Slow Production

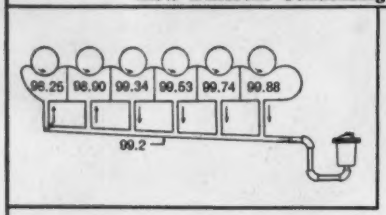


Fig. 1 This is a 6-roll ironer shortly after it has begun operating on 100 psi steam. When cold, wet material passes over chest 1, steam condensing rate is high and pressure drops accordingly. The pressure drop in chest 2 will not be as great, and so on down the machine as the material becomes progressively hotter and drier. Average pressure in the chests then is 99.27 lbs., and drain header pressure is slightly less, about 99.2 lbs. Under these conditions, steam from drain header enters chests 1 and 2 (as indicated by arrows at side of drain lines) because of pressure difference. Though condensate from chests drains by gravity, air can't leave chests countercurrent to incoming steam. Fig. 2 shows what happens next.

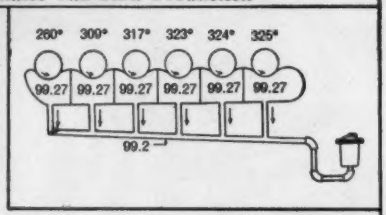


Fig. 2 This is the same 6-roll ironer after it has been operating a while. Air has accumulated in chests 1 and 2, reducing condensing rate and decreasing pressure drop. This process repeats itself down the line until pressures are as shown—that is, enough air will accumulate in each chest so that condensing rates and pressure drops of all chests will be about equal. The net result is shown in chest temperatures which are actual pyrometer readings taken on a 6-roll ironer, drained by a master trap, in a Chicago laundry. The laundry was making 337.9°F steam, but getting an average of only 309.6°F from the ironing surfaces, necessitating slow operation and frequent reruns. Then they tried Armstrong unit trapping—see Fig 3.

How Unit Trapping Prevents Trouble

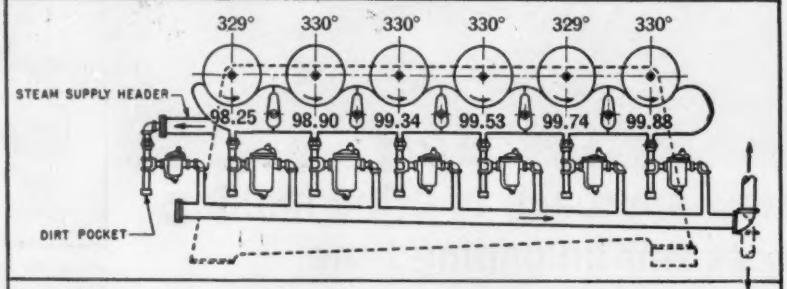
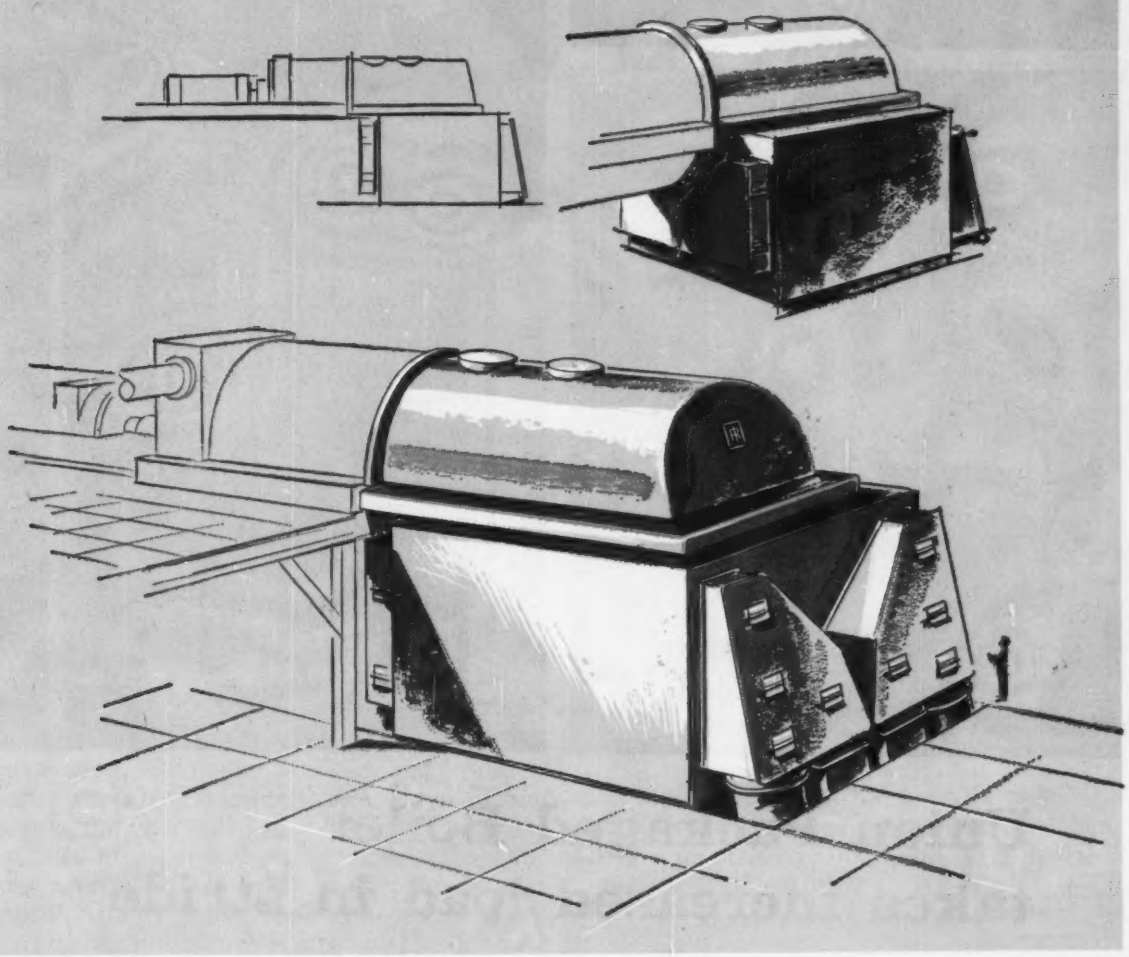


Fig. 3 This is the same 6-roll ironer, now unit trapped. Temperatures shown are also actual pyrometer readings—the average of 329.6°F is 20° higher than with group trapping. This is because air is continually removed from each chest into the drain header, and cannot get back into any chest.

Adding new dimensions *to engineering*



Here's the latest concept in steam condenser design*

(You'll be hearing about this one for a long time to come)

In no other installation has a surface condenser so completely matched the characteristics of the axial-exhaust turbine it serves. For the first time the condenser tubes have been arranged to parallel the turbine shaft resulting in a steam-flow path that is optimized to provide just the right back-pressure for high-efficiency turbine-condenser operation. At the same time, the condenser is arranged to complement the overall station planning—space requirements are minimized and piping is simplified without sacrificing accessibility.

At Ingersoll-Rand we like to apply new ideas and design concepts to the *overall engineering problem.* That's why I-R condensers continually set the pace for highest performance and adaptability to any *turbine-condenser arrangement.*

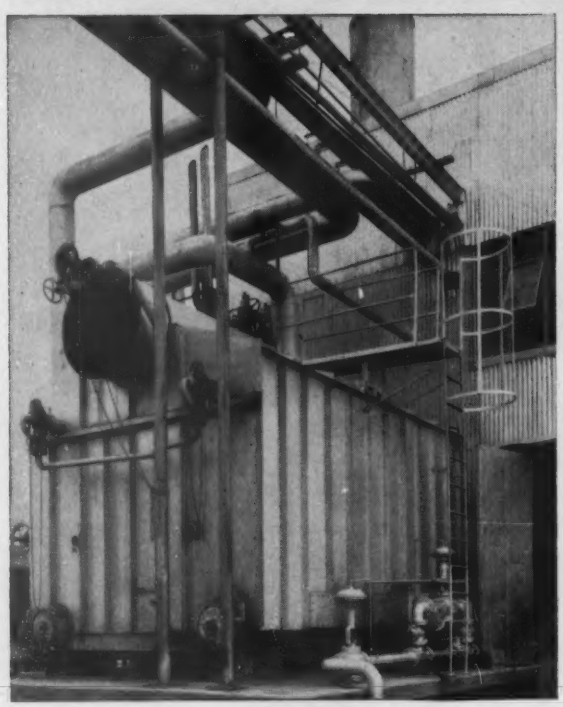
**Ingersoll-Rand Axial-Inlet Condenser with 145,000 sq. ft. of surface for Southern California Edison Company's Alamitos Station, Units 3 and 4.*

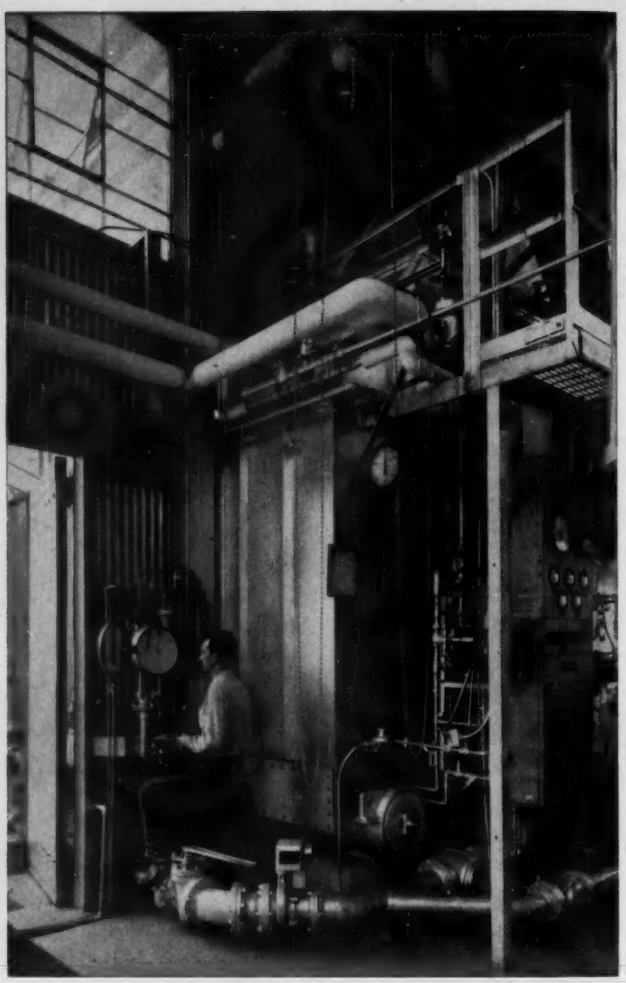
PUMPS • CONDENSERS • EJECTORS & VACUUM PUMPS
AIR & ELECTRIC TOOLS • AIR COMPRESSORS

Ingersoll-Rand®
11 Broadway, New York 4, N.Y.

For more facts circle 229 on Reader Service card, p 101

Processing wallboard at Kaiser Gypsum





Union Packaged Boiler takes increased load in stride

A good part of the steam for processing gypsum wallboard at Kaiser Gypsum Company's Long Beach plant is supplied by the Union Type MH Packaged Boiler shown.

Semi-automatic fired with a normal operating pressure of 200 psi, this compact unit went on the job in 1956. Installed outdoors, it eliminated the need for further extension of the existing boiler house.

Although originally furnished to deliver steam for 2 out of 5 zones in a Coe Dryer, the MH was later hooked up to carry more of the load handled by an older boiler. Says the engineer-constructor, Kaiser Engineers: "The extra load demand on the Union Boiler was hardly noticeable from an operating standpoint."

Throughout industry, similar reports verify reliable Union performance on stiff assignments. Job-proved designs, complete shop assembly, compactness, easy installation and above average efficiency combine to make Union MH Steam Generators the best dollar-for-dollar buy on the market.

Readily equipped to handle a great diversity of needs formerly requiring costly field erection and special engineering, Union Packaged Steam Generators are now operating at capacities over 100,000 lbs./hr.

UNION

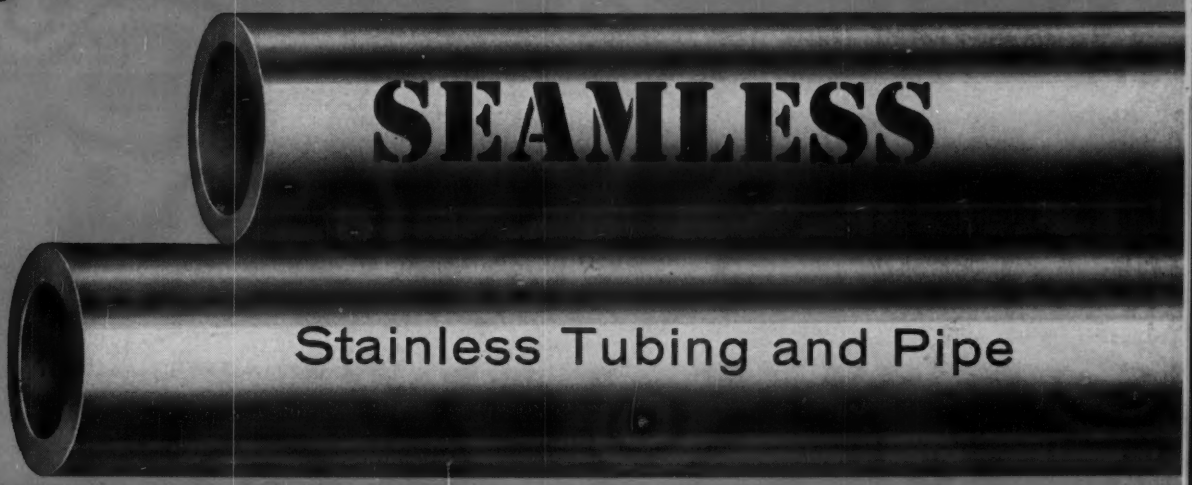
UNION IRON WORKS
ERIE, PENNSYLVANIA
DIVISION OF RILEY STOKER CORP.

For more facts circle 230 on Reader Service card, p 101

Circle 231 on Reader Service card, p 101 for following ad ➤

announcing . . .

Carpenter now makes



The right answers to a wide variety of corrosion and high temperature problems in heat transfer equipment and process piping systems are provided by SEAMLESS Stainless Tubing and Pipe now made by Carpenter. At every stage of their manufacture, the accent is on quality and uniformity. Both are initially hot formed by the best available extrusion process. Stainless alloys for their production are made in Carpenter's own specialty steel mill to closely balanced analyses. Consistently uniform structure and utmost freedom from impurities throughout these stainless steels are assured by Carpenter's exclusive Mel-Trol® process.

Cold finishing gives all Carpenter SEAMLESS Stainless Tubing and Pipe extremely close accuracy of O.D. and I.D. dimensions, excellent physical properties and super-smooth surfaces. Optimum corrosion resistance, strength and working properties are made certain by careful annealing, pickling and passivating under strict quality control. Rigid final tests and inspections insure that all Carpenter SEAMLESS Stainless Tubing and Pipe always is supplied exactly "as ordered".

Both tubing and pipe are available to ASTM, AMS and Government Specifications in a full range of standard stainless analyses and Carpenter Stainless No. 20Cb. Tubing sizes are ¼" to 6⅝" with wall thicknesses of .004" to .864". Pipe sizes are ⅛" to 6" in Schedules 5, 10, 40, 80, 120, 160 and Double Extra Heavy. Popular types and sizes of both tubing and pipe are available from large stocks in principal U. S. cities.

Get full information on your needs from the nearest Carpenter Representative or Distributor. A new Selecting and Buying Guide, Bulletin 128, is available on request to The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

selection geared to service

Carpenter steel

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Export Dept., Port Washington, N. Y.—"CARSTEELCO"
Alloy Tube Division, Union, N. J.
Webb Wire Division, New Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

Low - maintenance pocket positive nickel-cadmium

New 20-year Exide-Ironclad tubular with Silvium*

Flat plate Tytex with Silvium or calcium

Long life Exide-Manchex, Planté type, with Silvium

Trickle or HiLo charger

Constant voltage charger

BROADEST LINE—BATTERIES and CHARGERS—PLUS SERVICE

Exide recommends the power package best for your application

Which battery will give you the longest life? How much capacity should you have? What is the most efficient charger for you? See your Exide man. He can help you get your battery power for the lowest cost per year.

Battery application requirements are usually somewhat different for every installation. No one battery type is most economical everywhere. The fact is that the selection should be made on a basis of engineering calculation. This is what your Exide man does. And he can do so freely, because he sells not only the broadest line, but the complete power package: batteries, chargers and factory-supervised service.

Investigate this easy way of getting maximum battery economy. Send for complete information on the Exide Power Package for stationary battery applications. Exide Industrial Marketing Division, The Electric Storage Battery Company, Philadelphia 20, Pa.

*Silvium is Exide's patented corrosion-resistant grid alloy

Exide®

INDUSTRIAL MARKETING DIVISION
The Electric Storage Battery Company

ESB

Consulting Engineers: H. M. WILSON CO., INC., Philadelphia 30, Penna.

FOUR KEELER TYPE MKL STEAM GENERATORS EXCEED EFFICIENCY GUARANTEE AT SEARS

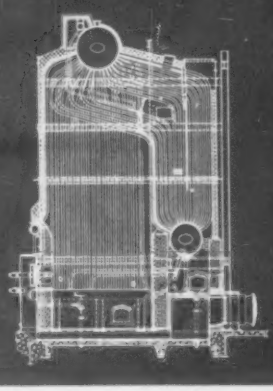
The Sears, Roebuck and Co. mail order plant in Philadelphia encompasses millions of square feet of usable space. The entire steam requirement plus adequate standby is supplied by four quick-response Keeler Type MKL Steam Generators installed in a recent modernization.

Test results have exceeded the guarantee of efficiency and their operation has been *"most satisfactory"!* The new MKL's are 40,000 lb stm/hr combination oil-gas, custom-designed units, 175 psi operating pressure. They were installed in the space previously occupied by four of the six 500-hp boilers which they replaced.

The space and versatility advantages experienced at Sears are typical of Keeler MKL's. The basic design provides true economy and efficiency with quick response to load changes. MKL's are cross drum, bottom supported type available in capacities up to 70,000 lb stm/hr. They're easy to maintain, flexible to space requirements, efficient and durable.

There's a dependable Keeler Water Tube Steam Generator for every requirement ... from low cost package units to 100,000 lb/hr and field erected units up to 200,000 lb/hr—for all fuels, all types of firing. *Write or phone for complete information ...*

KEELER MKL



WRITE FOR FREE BULLETINS ...
No. MKL-1: Type MKL Boilers
No. MK-1: Type MK Boilers
No. DK-2: Type DK Package Boilers
No. F-14: Type CP Boilers
No. M-2A: Type CPM Package Boilers

SEARS
ROEBUCK AND CO.
Mail Order Plant
Philadelphia

The plant serves catalog customers in 8 states and the District of Columbia. Also located here are Sears' eastern territory headquarters offices, a department store, rail and motor freight terminals and warehouses.

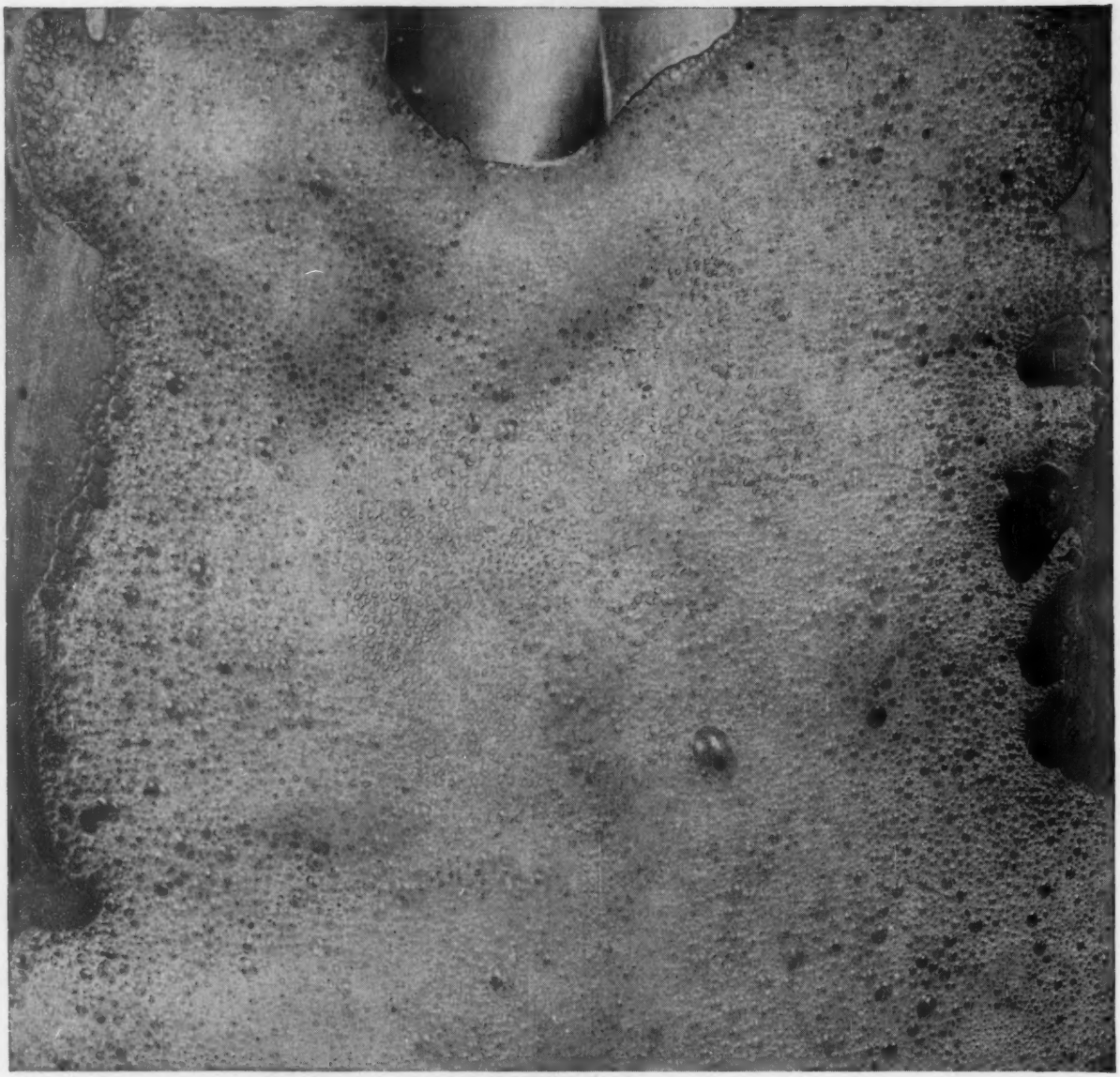
KEELER WATER TUBE Boilers

The Seal of Quality in Water Tube Steam Generators

— ESTABLISHED 1864 —

E. KEELER COMPANY
200-300 West Street
Williamsport, Penna.

— OFFICES IN PRINCIPAL CITIES —
In Canada: Canadian Vickers, Ltd., Montreal



Enlarged view of 40-times-expanded acid foam used by D.I.S. for equipment cleaning.

NEW ACID FOAM WITH A LIGHT TOUCH REMOVES TOUGH DEPOSITS FAST!

This active foam removes scale and deposits fast from all kinds of industrial equipment. It's inhibited acid, expanded 40 times. This new Dow Industrial Service technique works faster than liquid solvent cleaning . . . holds sloughed-off particles in suspension better . . . and needs less weight of liquid. Foam cleaning is thorough, economical, and takes minimum equipment downtime.

Developed by D.I.S., this economical foam cleaning technique is more effective and thorough than conventional fill-and-soak cleaning. The foamed solvent fills vessels, pipes, even bent tubing as a plug. There's no need for vent connections. Where the added weight of cleaning agents is critical, foam cleaning may be the only solution.

Nation-wide Dow Industrial Service cleans every kind of process and heat exchange equipment for almost every kind of industry, including chemical process, petroleum, and natural gas processors. In addition, D.I.S. offers complete consulting laboratory service for water treatment and waste processing problems, backed by the technical resources of The Dow Chemical Company. For cleaning *any kind* of equipment, *anywhere* in the U.S., write or call DOW INDUSTRIAL SERVICE, 20575 Center Ridge Road, Cleveland 16, Ohio.

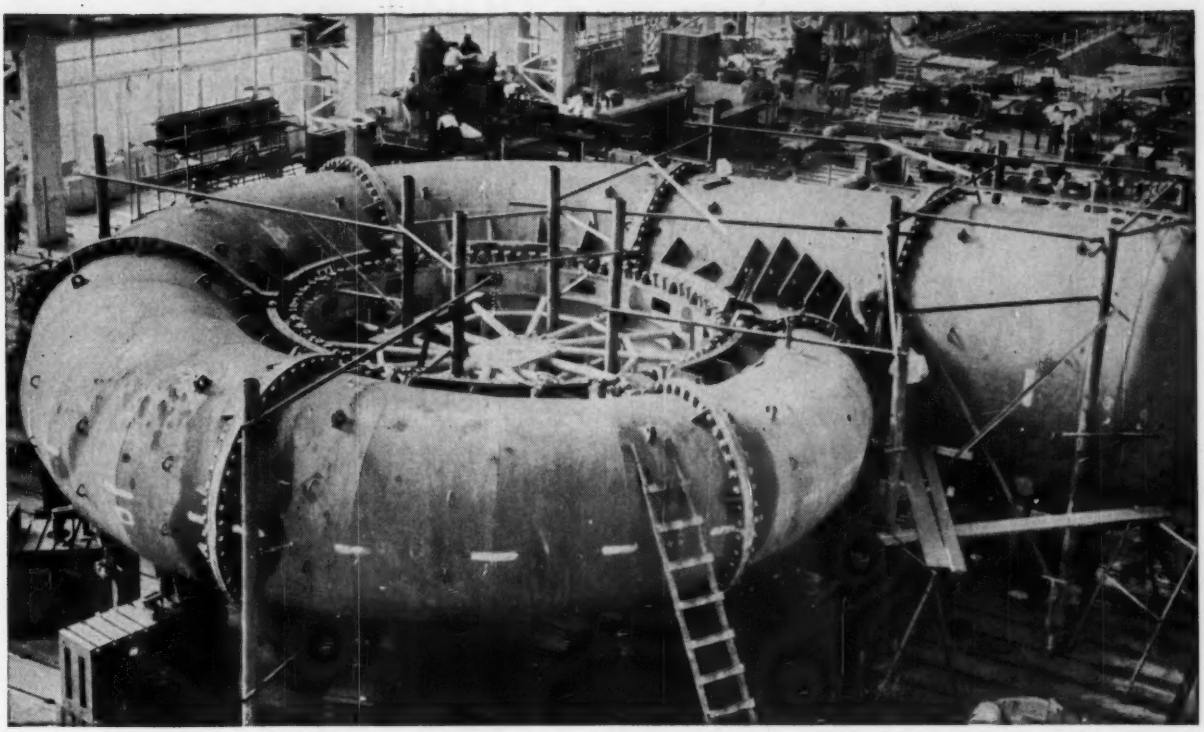
Write for a copy of this new booklet on Foam Cleaning.

DOW

DOW INDUSTRIAL SERVICE • Division of The Dow Chemical Company

HITACHI

now completing the first hydraulic turbines for Thailand's Yanhee Project



Shop tests were recently completed on the spiral casing for the first of two 115,000 HP Francis-type turbines being completed by Hitachi for Thailand's Royal Irrigation Department. These will be the first of the planned 8 sets of generating units to be installed at the downstream of the Bhumiphol Dam, as part of the Yanhee Multipurpose Project which will commence operation in 1963 and eventually supply 560,000 kW of power to Bangkok and Thonburi. The vertical shaft Francis turbines have been designed to deliver 115,000 HP under the effective head of 112m and for a speed of 150 rpm. Their spiral casings, with inlet diameter of 4150mm, will each be divided into 7 sections for transportation by barge up the Ping River to the site.

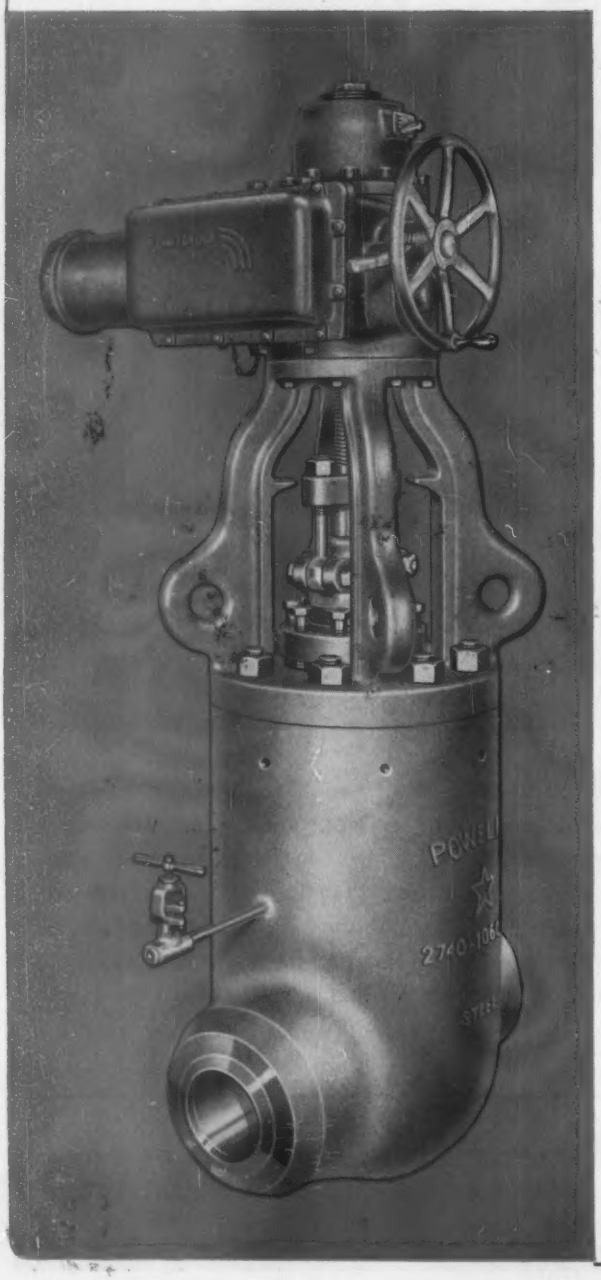
Hitachi, Ltd.
Tokyo · Japan
Cable Address: "HITACHY" TOKYO

EXTRA POWELL VALVE NEWS

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

115th year of manufacturing industrial valves for the free world

NEW HIGH PRESSURE–HIGH TEMPERATURE VALVE FOR POWER PLANT OPERATION



AT 2740 psig AND 1060° F

Powell proudly presents this new Pressure Seal O.S. & Y. Gate Valve, especially engineered for ultra high pressure-high temperature service in one of the nation's largest modern plants. Its outstanding performance results from many key design features, such as:

- Body, Bonnet and Wedge of Chromium-Molybdeum Steel, according to ASTM specification A-217, Grade WC9.
- Internal working parts constructed of long-wearing materials, proven for uninterrupted service under severe operating conditions. Stellite facings on the wedge and seat rings.
- A Chrome-moly Bleed-off Valve extends through the body and facilitates valve opening by relieving pressure within the valve when it is closed.
- The top mounted weatherproof Electric Motor Operator, for remote control, has a *Spring* that automatically compensates for the changes of contraction or expansion of the valve stem, wedge and body. Proper and precise seating at all times is assured.

Development of this new high pressure-high temperature gate valve is positive evidence of Powell's ability to meet any industrial valve requirement—with regular or special designs—in bronze, iron, steel or alloys—for water, oil, gas, steam, and corrosive service. For further information or assistance, consult your nearby Powell Valve Distributor, or write direct.

LOUIS N ROWLEY, EDITOR • JULY 1961 • ESTABLISHED 1882 **Power**

New honors for Edison

The memory of Thomas Alva Edison was honored twice in the month just past, and each honor, in its own way, reflected a different facet of an astonishingly fruitful career.

On June 4, a bust of Edison was dedicated in the Hall of Fame of Great Americans at New York University. To most of those who read the news accounts, the only surprising aspect of this event must have been that it had not occurred sooner, for here was an American who became a legend in his own long lifetime.

Fame of the conventional sort would have come to anyone, at any time, who accomplished what Edison did. But circumstances conspired to give his fame a special quality, to make him a true folk hero, "the wizard of Menlo Park."

For one thing, the period of his greatest pioneering activity coincided with the tremendous upsurge in industrial development that marked the last half of the 19th century. In this atmosphere, with its heightened awareness of technical progress, Edison brought into being the incandescent lamp, the phonograph and the moving picture, all of which had a direct and visible public impact. Central electrical systems and electric lighting changed the face of America's cities and towns, the phonograph and the movies opened new worlds of entertainment.

Add to this a life story that might have been written by Horatio Alger: humble beginnings, the romance of early days as a telegrapher, a meteoric rise, the recurrent suspense of struggles against technical and business adversity, the triumphs when all seemed lost.

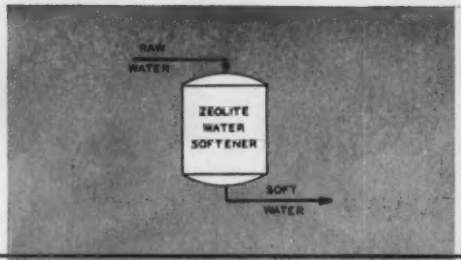
Finally, there was the man himself—a true original. Homespun, eccentric in his work habits, outspokenly scornful of theory and "experts," he was the stuff of which legends are made. Small wonder that he captured the public imagination, became the symbol of inventive genius.

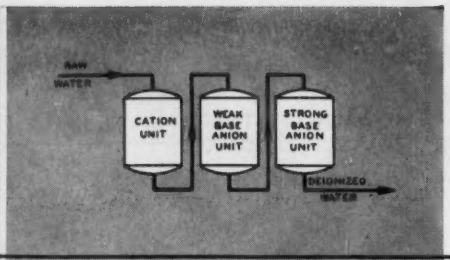
And inventive genius he was, but not the *lone* inventor the popular legend tends to make him. He knew the value of team effort and despite public utterances, he knew, and used, the contributions of theorists and specialists. Intuition played a key role many times, but he depended on painstaking investigation. To a startling degree his methods, particularly in the latter part of his career, forecast the modern approach to research and development. More than anyone before him, Edison made invention an organized business activity, the basis for creation of successful manufacturing enterprises, the essential dynamic ingredient of industrial growth.

This facet of Edison's work led to his being summoned to Washington in 1915 to organize the Naval Consulting Board and man it with the nation's top scientists, engineers and inventors. After the First World War was won, this became the Naval Research Laboratory and for the first time our national defense was backed by continuing organized research.

It was in recognition of this contribution that, on June 16, the newest Polaris type nuclear-powered submarine was christened in Edison's name. Fittingly, its control system is protected by instruments developed and produced by the McGraw-Edison Company, corporate heir of the great inventor.

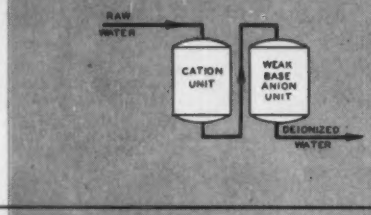
Delivers soft water by the simplest and most dependable method of softening water—the zeolite softener.

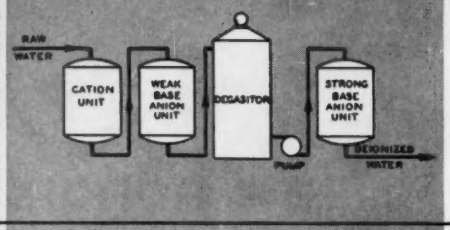




Delivers high quality CO_2 and silica free deionized water. Used to treat water of relatively low alkalinity.

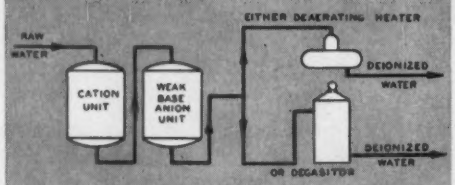
Delivers deionized water low in dissolved solids—suitable for many boiler and process applications.

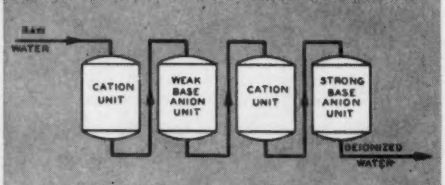




Delivers deionized water, free of CO_2 and silica. Very effectively used for waters of high alkalinity.

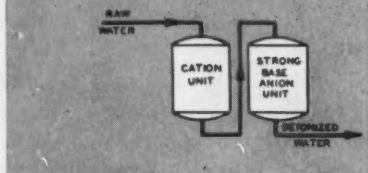
Delivers deionized water and eliminates CO_2 with either deaerating heater or degasifor.

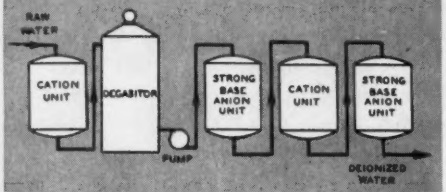




Delivers exceptionally high quality deionized water, free from silica and CO_2. Effectively used on waters of low alkalinity.

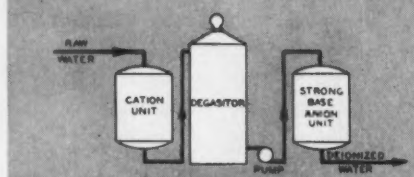
Delivers deionized water free from silica and CO_2. Used largely for waters of low alkalinity.

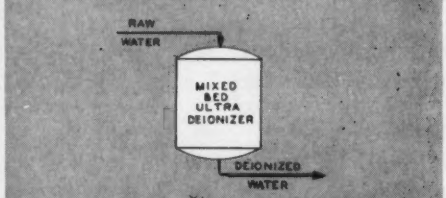




Delivers highest quality deionized water, free from silica and CO_2. Last two columns provide the "polishing" steps.

Delivers deionized water free from silica and CO_2. Usually built in large sizes for low cost CO_2 removal.





Delivers deionized water of highest known quality—free from silica and CO_2. Used alone and as "polishing" unit.

Yes, there is an Elgin ion exchanger that will exactly meet your needs . . .

Some of the modern methods we are using today are diagrammed above . . . and there are many combinations of these dictated by the variables in water supply and final use.

But whether your requirements can be met by a simple zeolite water softener—or whether you need the most highly "polished" water—this much is certain: The best and most economical solution to your problem must come from a firm like Elgin that offers *every* modern and authoritative approach.

Write for the Guide to Better Water Treatment — Bulletin 615

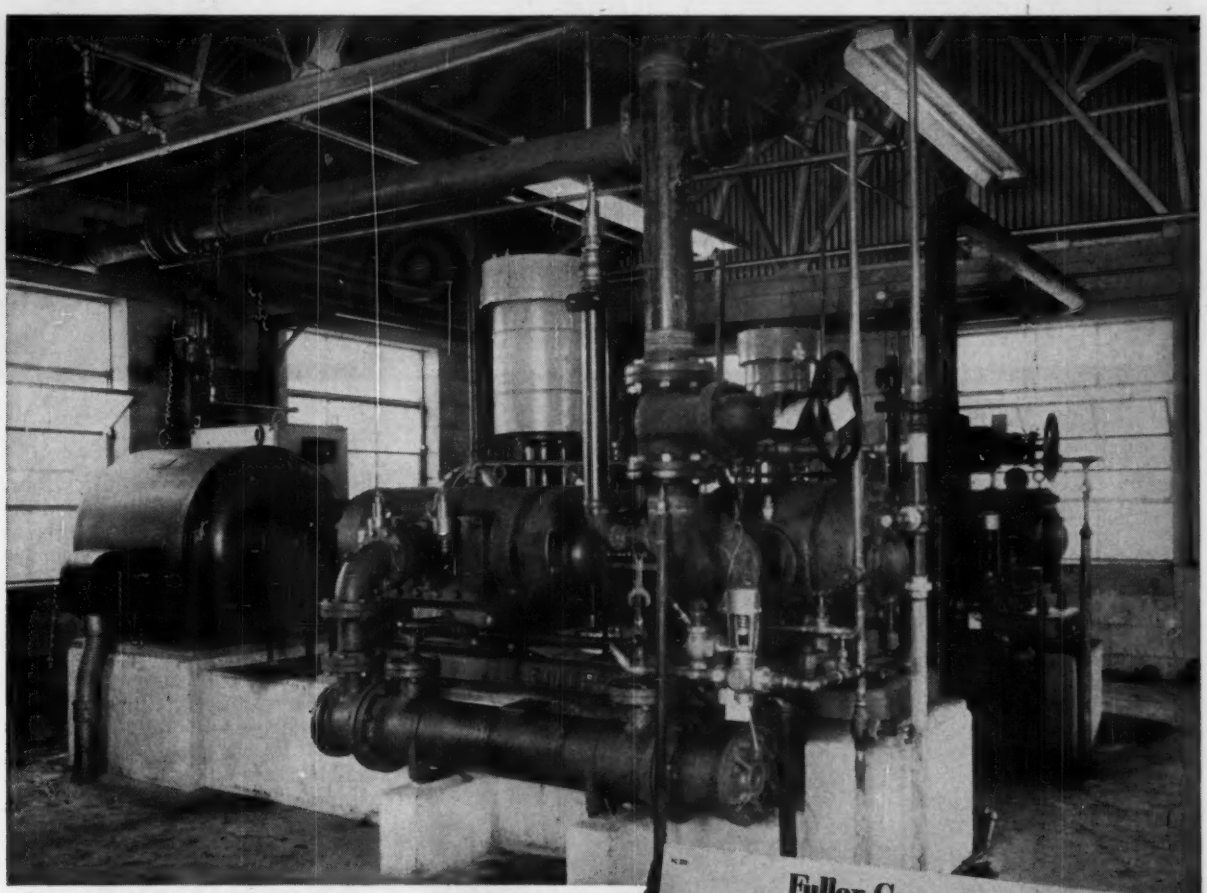
ELGIN SOFTENER CORPORATION

130 North Grove Avenue • Elgin, Illinois

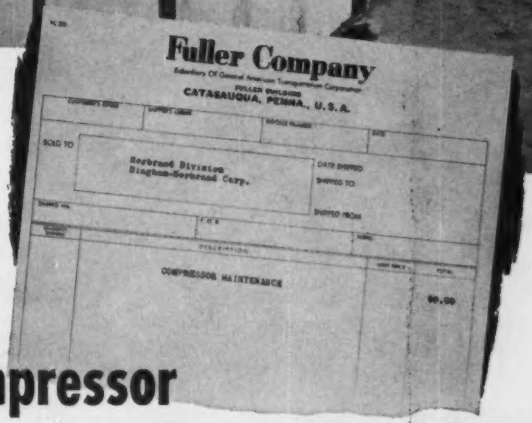
Representatives in Principal Cities • In Canada: G. F. Sterne & Son Ltd., Brantford

ELGIN
WATER CONDITIONING
SINCE 1908

For more facts circle 237 on Reader Service card, p 101



Two C135/135H Fuller Rotary Compressors at the Herbrand Division of the Bingham-Herbrand Corp., Fremont, Ohio, leading manufacturer of forged mechanics' hand tools and steel forgings for the automotive industry. Each compressor is rated 680 cfm, atmosphere to 100/110 psig., at 690 RPM.



Here's the 4-Year Maintenance Bill on Fuller Rotary Compressor at Herbrand Division of Bingham-Herbrand Corp.

So satisfactory was the performance of its first Fuller Rotary Compressor, installed in 1956, that Herbrand Division installed another like it 3½ years later.

When the older unit was inspected after four years operation, no replacement of parts was necessary. After installation of a new gasket (cost $9.35)—to replace the one that had to be removed to make inspection—the compressor continues to add to its service record.

The newer compressor has also been entirely trouble-free, and Herbrand plans a third, when increased air capacity is required. It, too, will be a Fuller—for, as Herbrand says, "These compressors can be classified as maintenance-free."

Because Fuller Rotary Compressors are practically vibration-free, they can be installed without complicated or expensive foundations or structural modifications. They are simple and efficient, with no valves to leak, no seats to grind. Blades automatically compensate for wear. They have forced-feed lubrication to all parts within the cylinder. Rotor, bearings and blades are the only moving parts.

Fuller Compressors range from 30 to 3300 cfm, pressures to 125-lb. gauge.

Write for Bulletin C-5A. It tells the whole story.

See Chemical Engineering Catalog for further details and specifications.

2852
C-364

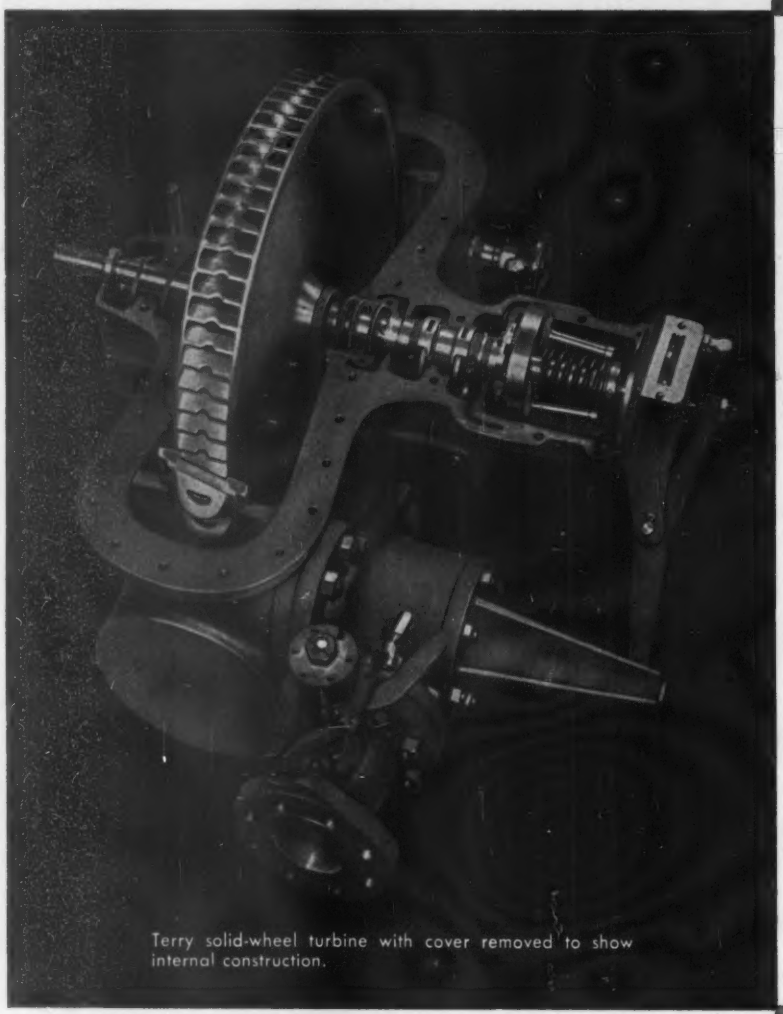
FULLER COMPANY
126 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
....pioneers in harnessing AIR

For more facts circle 238 on Reader Service card, p 101

TERRY SOLID-WHEEL TURBINE

spells service continuity for mechanical drives



Terry solid-wheel turbine with cover removed to show internal construction.

For mechanical-drive applications, such as these, you will never find the equal of Terry solid-wheel turbines for built-in dependability. They are *designed* for trouble-free operation under the toughest service requirements.

The wheel, for example, is a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out. The blades can't foul since they are double-rim protected...with one-inch clearances at either side.

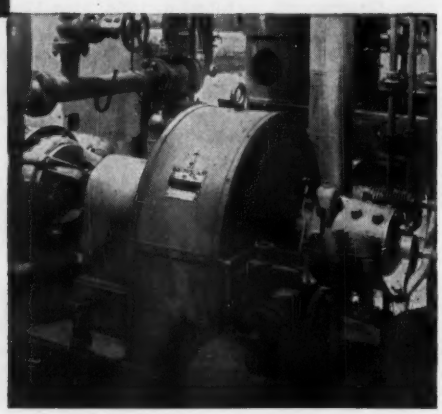
Any blade wear, which might occur after years of service, is of little consequence. As the power-producing action of the steam takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

Specify Terry solid-wheel turbines for your next mechanical drives. They are available in capacities from 5 to 2,000 hp., speeds up to 10,000 rpm. Vertical turbines are built in sizes from 5 to 300 hp.

For full information about these reliable turbines, send for bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY



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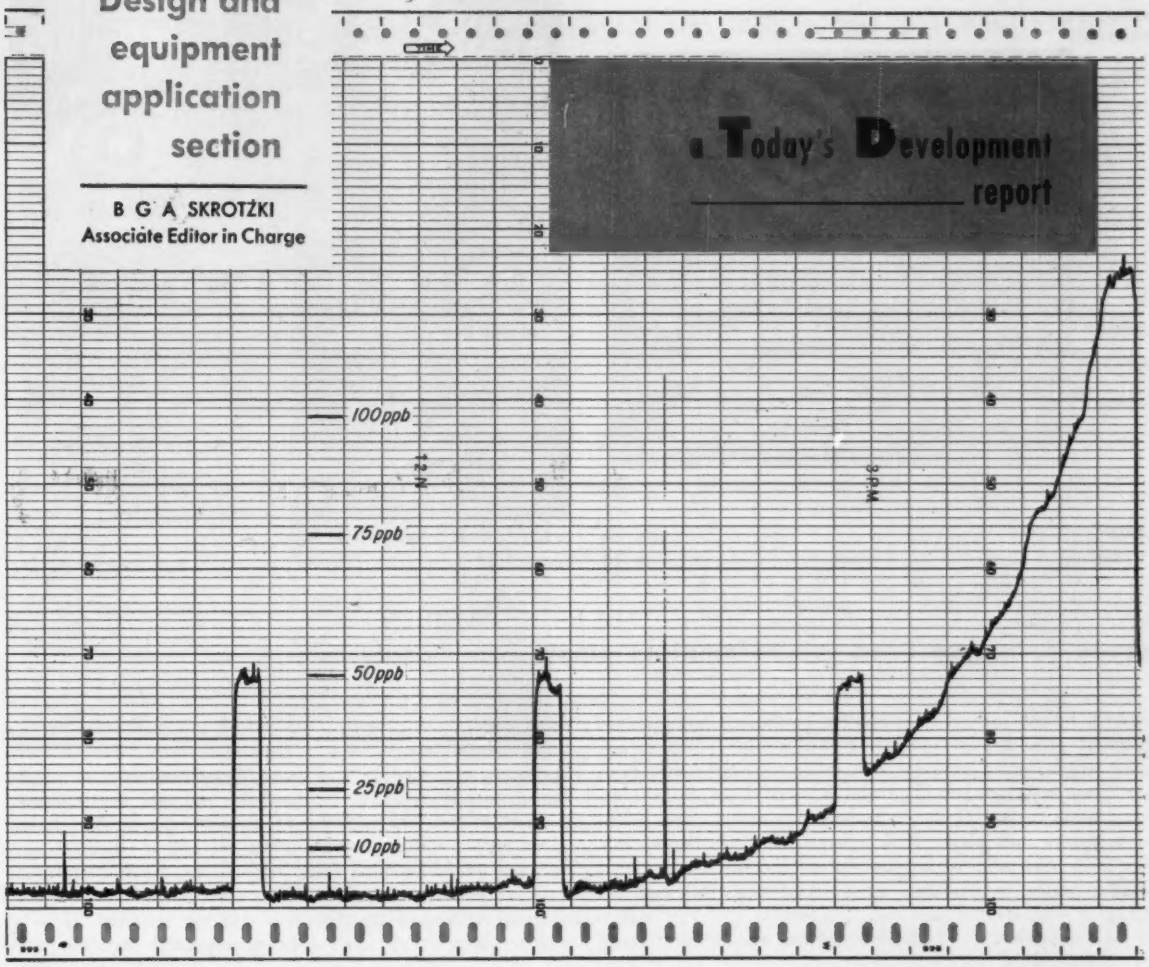
Today's Development report



SILICA BREAKTHROUGH shows clearly on continuous record of demineralizer effluent at Consolidated Edison's Waterside station

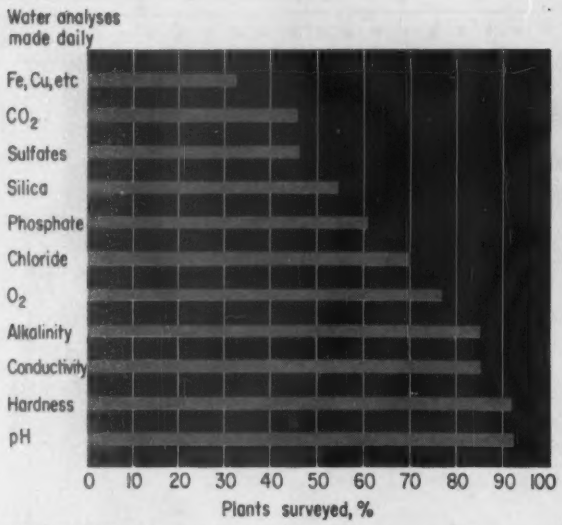
Automatic water analysis takes hold

Makeup, feedwater, boiler water, condensate and cooling water are prime candidates for automatic analysis. New analytical instruments now detect silica, iron, sodium and dissolved oxygen in the ppb range

By R H MARKS, Associate Editor

Analytical instrumentation has an expanding role in plant operation for two basic reasons. First, increased operating pressures and temperatures in the modern power plant greatly magnify the importance of both water and steam purity. The degree of purity now called for is fantastic by conventional standards. Trace concentrations in the ppb range must be monitored in boiler water, steam condensate and other plant streams. Changes in impurity level must be spotted immediately so corrective action can begin, to prevent serious problems.

Second, the trend to automatic operation of water-treating equipment like softeners, demineralizers and chemical feeds has created a real need for auto-



SURVEY RESULTS show wide variety of water analyses run on a regular basis. Hardness, pH, conductivity and alkalinity top list

WATER-TREATMENT ROOM is focal point for the plant's sampling system. Manual titration, above, plays basic role in water testing

Survey points up need for automating plant water analyses

POWER's recent survey of engineers concerned with water-treatment problems in industrial and utility plants established which water analyses are made regularly and how often these tests are run. The plants covered by this survey have a wide variety of water-treating equipment. Over 83% use softeners and about 75% operate demineralizers. Another 50% have cold- or hot-process softeners.

Boiler water is analyzed most frequently, followed by feedwater and treated makeup. Condensate and raw water get least attention. Most analyses, above, are made at least three times a day, and some plants check more than 15 times. More than 33% run anywhere from 6 to 15 daily hardness and alkalinity tests. Although automatic instruments usually measure conductivity and pH continuously, most water tests are performed manually on a periodic basis.

Automatic water analysis offers attractive potential savings and other benefits. Over 90% of those surveyed would consider automatic analytical instruments for various water analyses in their plant. However, opinion was divided as to whether or not their use can be economically justified.

---

matic water analyses as a key control-system link. Otherwise, manual analyses must be run regularly to adjust chemical feeds and determine when softeners and demineralizers are ready for regeneration. All this adds up to a growing demand for analytical instruments that must be accurate, reliable and run continuously under a wide range of adverse conditions.

Conductivity and pH measurements are extremely valuable operating tools. Conductivity helps by giving a measure of total dissolved solids; pH indicates the degree of acidity or alkalinity. These determinations can be made on grab samples with manually operated test equipment. But the extreme purity of many samples and the need for continuous data has led to widespread use of automatic instruments, which monitor flowing samples sent through a closed flow-cell. Almost every industrial plant checks boiler water, feedwater, condensate and makeup. In chemical-feed systems, pH instruments control the addition of acid or caustic to cooling-water streams. Conductivity is also important in demineralizing.

Colorimetric analysis usually determines silica, iron and phosphate in low concentrations. Grab samples, taken in the plant, are brought to the laboratory for analysis. But this test procedure is not fast enough to follow minute-to-minute or even hour-to-hour changes in operating conditions. For example, silica breakthrough in the effluent of a demineralizing system is particularly difficult to spot with manual-test routines.

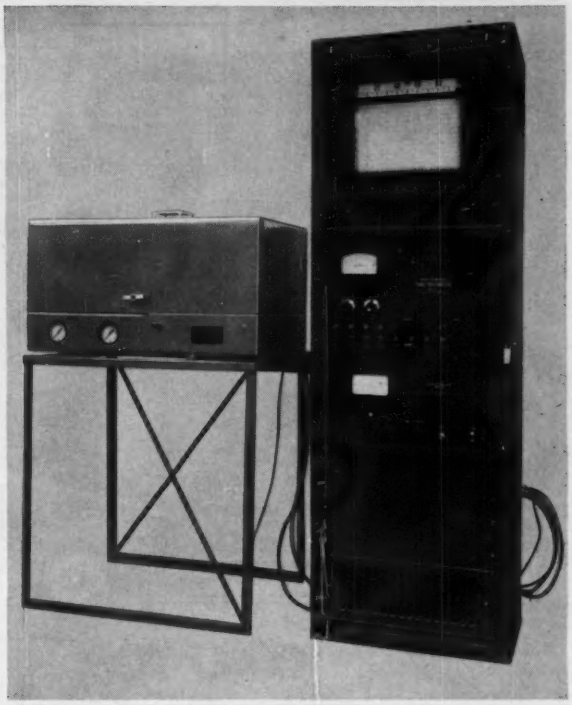
Consolidated Edison Company tackled the problem at their Waterside Station with an automatic colorimeter that continuously analyzes demineralizer effluent for silica. Chart from the plant, previous page, clearly shows silica breakthrough that signals end of the run. When silica exceeds some preset value, say 100 ppb, the demineralizer in question is immediately taken off the line and regenerated.

At present one instrument serves the entire battery by monitoring each demineralizer only when it nears exhaustion. Periodic blips on the record chart represent a standard sample containing 50-ppb silica that is automatically sent through the instrument every two hours. This maintains an accurate reference scale for subsequent analyses. Only soluble silica is detected now, but developments in the wind will soon make it possible to determine total silica.

Automatic colorimeter (Technicon Controls, Inc), facing page, checks

These instruments continuously monitor phosphate, sodium and dissolved oxygen

COLORIMETRIC ANALYZER automatically makes and records 240 phosphate tests a day on water samples from ten different boilers



ULTRASENSITIVE FLAME PHOTOMETER determines and records traces of sodium in condensate, boron in nuclear-reactor loop

phosphate concentration in the boiler water from ten different boilers at the same station. This instrument has been in service now for over two years. It makes one analysis on each boiler every hour. Recorded phosphate levels aid plant operators in regulating amount of chemical treatment and blowdown for each boiler. Colorimetric devices are also employed at many other plants, analyzing silica, iron, chlorides, hardness.

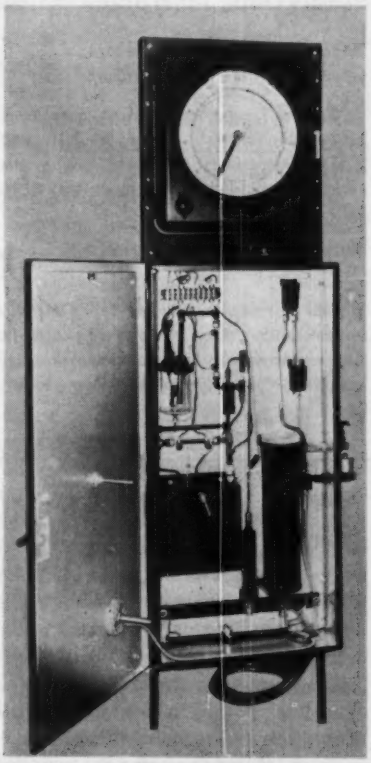
Dissolved oxygen is usually checked by periodic manual tests of feedwater and deaerator effluent. But many oxygen recorders are in service; they measure thermal conductivity of hydrogen that has reached equilibrium with the sample. These instruments give dependable, accurate results on mechanically deaerated water, although if chemicals like hydrazine are present, readings may be abnormally "high."

Gas-transfer type instrument, right, a recent development, avoids this kind of interference. It operates by drawing a continuous sample of water, then scrubs out entrained gases with hydrogen. The resultant mixture goes through an electrochemical cell that produces an electrical output proportional to the amount of oxygen present in the sample.

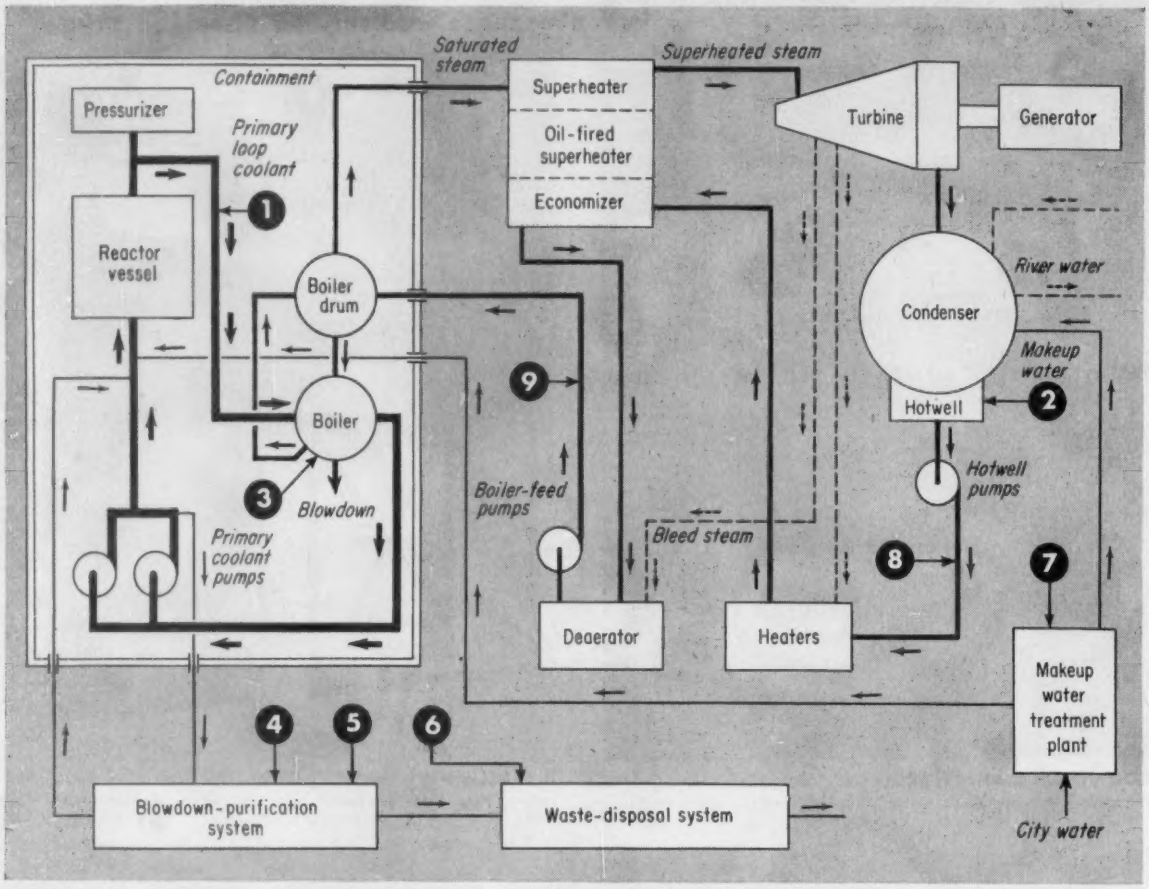
In combination with pH, hydrogen and hydrazine recorders, this unit controls a completely automatic hydrazine and ammonia feed system at the Bergen Station of Public Service Gas and Electric Company.

Sodium analysis. For many years conductivity has been used to check steam purity. But steam from modern boilers and evaporators is now so pure that conductivity measurements are not very satisfactory. One alternate method: use flame photometry to analyze samples of condensed steam for sodium. Recording flame photometer, above, measures sodium concentrations as low as 0.1 ppb. It provides for multipoint sampling, automatic self-calibration and range changing and various alarms. Designed for continuous unattended operation, it has an important operating role at the Indian Point Nuclear Power Station.

Indian Point Nuclear Power Station (Consolidated Edison Co of New York) has all the usual components of a normal steam-power station with one notable exception: its boiler is composed of four special



DISSOLVED-OXYGEN RECORDER, gas-transfer type, has range of 0-50 or 0-200 ppb, checks work of mechanical deaerators



Analytical instrumentation is vital part of Indian Point Nuclear Power Station

Recording flame photometers
(Waters Associates/Consolidated Edison)

1 One instrument, cycling four loops, monitors boron concentration for reactor control. Range is 0-10 and 0-10,000 ppm H_3BO_3
2 Two instruments check condensate for condenser leakage. One cycles four hotwells, other is on hotwell-pump discharge. Range is 0-10 ppb Na

Automatic colorimeters
(Technicon Controls, Inc)

3 Four instruments, one per boiler, measure chlorides in the boiler to spot buildup from condenser leakage. Range is 0-300 ppb NaCl
4 One instrument for inlet blowdown-purification system analyzes composition of primary coolant. Range varies with the type of analysis
5 One instrument for blowdown-purification system checks ion exchangers, other purification equipment. Range varies with analysis
6 One instrument for waste-disposal system monitors performance of treatment units such as evaporators. Range depends on type of analysis

Oxygen analyzers, gas-transfer type
(Cambridge Instrument Co, Inc)

7 One instrument checks oxygen in makeup water and monitors deaerating preheaters on evaporators. Range is 0-50 or 0-200 ppb O_2
8 One instrument analyzes oxygen content of main condensate stream to spot any air leakage into the condensate circuit
9 One instrument monitors oxygen content of boiler feedwater and also checks performance of mechanical deaerator
10 One instrument, not shown, measures oxygen in feedwater for the service boilers and also monitors deaerator performance

heat exchangers. Circulating water at high temperature and pressure from the nuclear reactor supplies heat. The reactor, a breeder type, makes the heat by controlled fission of uranium 235 and also produces uranium 233 from thorium 232. Flow diagram of plant, above, shows all the basic circuits. Radioactive wastes are removed from the primary loop and handled by the purification and disposal system. The water-treatment plant provides ultrapure water. Automatic colorimeters, dissolved-oxygen recorders and flame photometers, tabulated above, are key parts of the overall system.

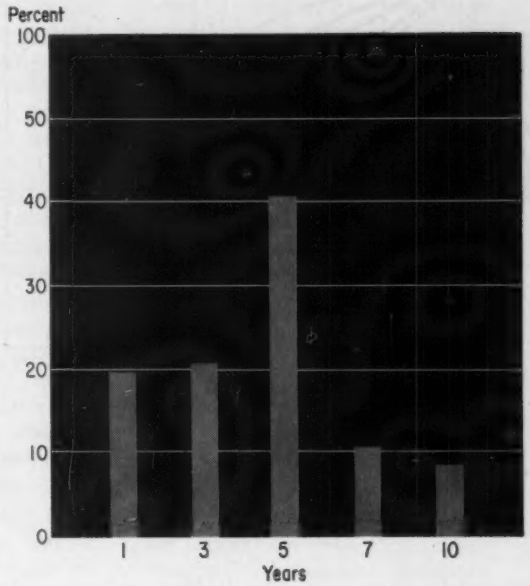
In addition there are over 20 recording pH and 25 conductivity instruments (Leeds & Northrup Co); some have automatic control jobs. They monitor primary coolant, blowdown-purification system, waste-treatment system, makeup-water treatment, boiler water, main condensate, boiler feedwater, etc. Automatic continuous sample concentrators under development will feed automatic analyzers continuously. They extend instrument sensitivity by concentrating the sample as much as 100 times. Radioactive isotopes will be identified by gamma-ray spectrometry and other radio-

How soon will automatic water analysis be common in power plants?

Graph, right, shows how engineers in our survey answered this question. Some feel widespread application is just around the corner. Others believe it will take ten years or more. But over 80% of those responding feel that automatic water analysis will be common practice within the next five years.

W A Crandall of Consolidated Edison Company, Inc of New York, an expert and pioneer in this field, says:

"Economics definitely favors increased use of automatic analytical instrumentation in most large new steam-electric stations. A single unit may represent an investment of 50 to 100 million dollars. This huge investment is justified because of the greater efficiency of these units. If the load carried by such a unit is transferred to an older one the differential cost may run as high as $10,000 a day. The value of an instrument to spot operating trouble in time to correct it with minimum downtime is readily apparent. Preventing a single incident involving several hours' outage may well save enough to more than pay for the analytical instrument involved. To perform this task successfully the instrument must be on the job continuously 24 hours a day, week after week, often under adverse ambient conditions. Reliability and freedom from excessive maintenance are key factors in the evaluation."



chemistry analytical techniques.

The recording flame photometers we've already described have two basic functions. First, the system must be kept free of chlorides to prevent stress-corrosion cracking of austenitic stainless steels in piping and equipment. Condenser leakage is the most probable source of chloride contamination. Since this is a closed system, any chlorides would quickly concentrate in the boilers, so to avoid the possibility, recording flame photometers continuously monitor sodium at the four condenser hotwells. Another instrument checks the hotwell-pump discharge. When sodium (and chloride) exceeds preset limits an alarm sounds and condenser section containing the leak is automatically isolated—fortunately, relatively fixed ratios of sodium and chloride are present in the river water.

Second, boric-acid concentration must be closely watched when it is added to the primary loop during startup periods. Boric acid controls the excess radioactivity by absorbing neutrons in the boron. It is removed from the system at equilibrium.

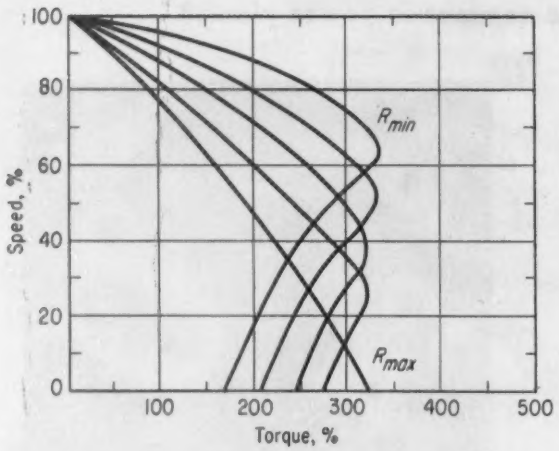
***Power*'s just-completed survey** on analytical testing of water indicates the variety and extent of analyses made regularly by industry. The majority surveyed are optimistic about the possibility of automatic water analysis becoming common practice within five years. But opinion was divided on whether or not it can be economically justified now.

Optimists cite many advantages of automatic analysis, including (1) saving in time and labor (2) improved reliability and accuracy that go along with the minimized human element and (3) better treatment control. Pessimists feel the initial price of many automatic devices is too high to justify their obvious advantages. Others have reservations about the maintenance involved. Some even feel that their operators can easily handle routine tests since they don't have enough to do as it is.

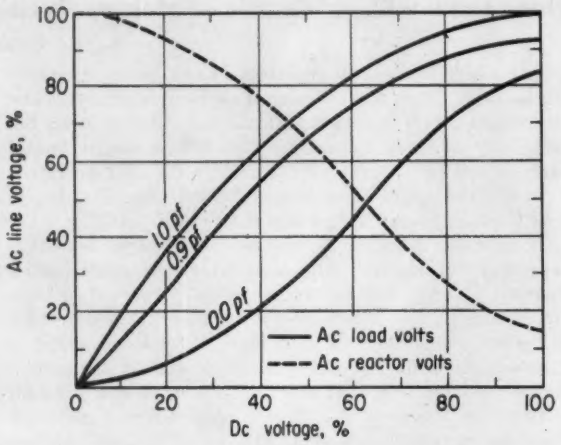
One modified scheme of automatic analysis and control is currently being considered for plants with boilers operating in the range of 250 to 600 psig. It involves close automatic monitoring of boiler feed for hardness and oxygen, of blowdown for conductivity. Blowdown is also hydraulically coordinated with the steam load. A uniform quantity of phosphate for hardness residual and sulfite for oxygen residual is added continuously to the boiler. Amount of chemical fed can be checked once a shift for routine control. Then as long as the feedwater is soft and deaeration uniform, no regular analyses are needed. Testing can be limited to a weekly basis by the plant laboratory.

Our survey clearly shows that automatic analytical instrumentation will increase its importance in plant design and operation. If you want to probe this area further, you'll find these references worthwhile:

(1) Crandall, W A: "Automatic analytical instrumentation in the modern power plant," *Annals*, New York Academy of Sciences, 911-923 (1960). (2) Schunk, K F: "Continuous sampling and automatic analysis of silica in modern high-pressure boilers," *Annals*, New York Academy of Sciences, 923-924 (1960). (3) Ferrari, A and E Catanzaro, "A new system for the completely automatic analysis of boiler and condensate waters in power plants," *Proc American Power Conference*, 722-728 (1959). (4) "Automatic water analysis shows promise," POWER, October 1958, annual *Plant Design Issue*.



1 Varying resistance R in rotor circuit produces this family of curves. Torque is maximum when R = the rotor reactance



2 Saturable reactor, in series with ac load, controls load voltage by varying its internal voltage drop through reactance changes

Saturable-core reactors in the primary circuit sometimes outshine conventional methods of wound-rotor motor control. Let's see what circuitry and characteristics are involved when . . .

Reactors control wound-rotor motors

By J E FREDERICK, Westinghouse Electric Corp

The wound-rotor motor boasts two prominent advantages. First: the motor can be reversed by interchanging two line leads. Second: controlling primary voltage and secondary (rotor) resistance gives adjustable speed. And adding secondary resistance not only increases starting torque, but materially reduces starting current. These characteristics make the wound-rotor motor a good bet for many types of service. One important one is driving ac hoists.

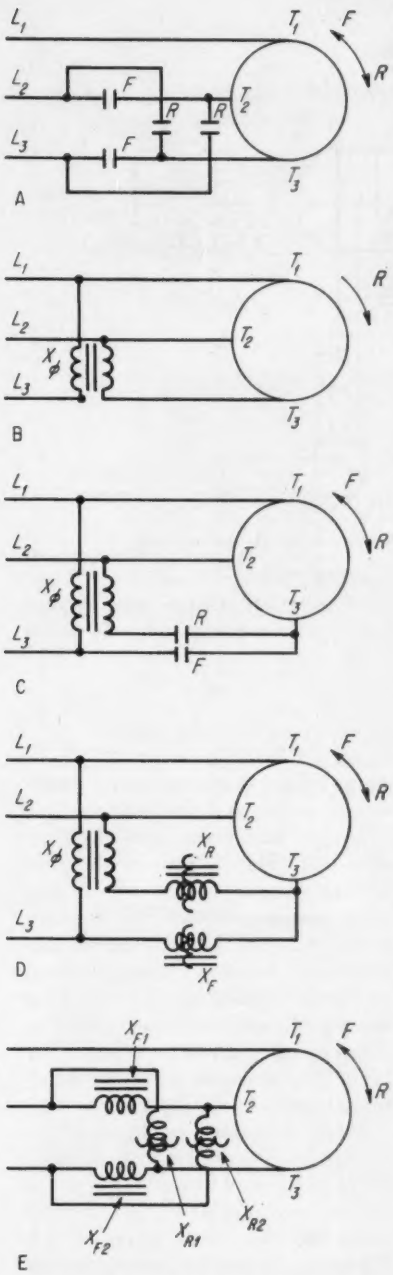
Torque varies as the square of the primary voltage. At a given speed, the available torque also can be adjusted by changing rotor circuit's resistance (see POWER's special report, *Motors*, June 1955). Adding resistance causes the pullout point to come at a lower speed, producing a family of speed-torque curves like those in Fig. 1. Varying secondary resistance R expands the torque curves vertically. Reducing motor primary voltage V_m from line voltage V compresses the curves symmetrically and horizontally by about the ratio $(V_m/V)^2$.

Control functions required in a hoist drive are fairly typical of wound-rotor requirements. Motor must pull to lift its load. It must be reversed to drive a light load down when friction is larger than force resulting from load weight. Speed and torque of drive motor must be altered to meet load requirements, to provide speed control of the load. Overhauling loads must be restrained in some way. (*Plant Electrical Fact File* in POWER, June 1960, pp 246 to 247 shows how an ac hoist works.)

Conventionally, "lift" and "lower" motions of the hoist are controlled by switching incoming power leads and adding resistance to the armature circuit or taking it away. Certainly this method is simple and relatively cheap. But contactor type of control has disadvantages of contactor maintenance; speed-torque must be controlled in steps. A static switch doesn't have these drawbacks. Right now, saturable reactors are the engineer's choice for static control of ac drives.

A *fixed* reactor is a single-winding device. There is no external means of varying or controlling its impedance. Winding is designed to withstand rated alternating current intermittently or continuously, depending on application. The reactor's impedance is fixed when it is tied to a given power supply; this property, however, does vary with primary frequency. Impedance changes in proportion to frequency. It's high at high frequency; at low frequency it is low—a valuable characteristic in induction-motor control.

In a *saturable* reactor, the impedance can be controlled, and this is done by adding a secondary control winding. Impedance of the primary ac power winding is adjusted by the



3 Development of wound-rotor control can be traced through steps *A* to *E*. *A* shows reversal by forward (*F*) and reverse (*R*) contactors. At *B* and *C*, phase-shifting transformer *Xφ* produces reversal. At *D*, *E*, saturable reactors replace contactors

level of dc applied to the control winding. An increase in the direct control current reduces the ac winding impedance, Fig. 2.

For example, if a load is connected in series with the primary winding of a saturable reactor and the control winding is not energized, only a small amount of current flows through the load. Consequently the voltage drop is across the reactor rather than the load. If the dc control winding is excited, the impedance of the reactor and the voltage drop across the reactor decrease. At zero control current, reactor impedance is high (analogous to open contactor); at rated dc the impedance is low (analogous to closed contactor). In addition to "off" and "on" states, intermediate levels of impedance or voltage drop are functions of dc control excitation.

In crane design, the direct control current for regulation of saturable-reactor impedance can be selected directly by potentiometer or inductor adjustment. Or it can be selected by the dc output (rectified ac) of a magnetic amplifier whose control windings receive adjustable inputs by similar means. Though many variations are possible, let us consider crane control using either two or four saturable reactors, depending on degree of static operation you want and just how sophisticated the characteristics must be.

The 2-reactor (single-phase) scheme controls reversing and variation of terminal voltage or balance by changing the excitation between two saturable reactors. Fig. 3 shows schemes for forward and reverse rotation. At *A*, four contacts provide this function. When contacts *F* are closed and contacts *R* opened, *L1* is connected to *T1*, *L2* to *T2* and *L3* to *T3*, providing forward rotation. If contacts *F* are opened and contacts *R* closed, *L1* remains connected to *T1*, but *L2* is connected to *T3* and *L3* to *T2*, thereby reversing the drive.

Another method of reversing inserts a 1-to-1 transformer in one phase, shown at *B*. This phase-shift transformer *Xφ* shifts one phase 180 deg, reversing the phase and thereby the rotation.

If two contactors *F* and *R* are provided as shown at *C*, the one phase to the motor terminal can be connected for positive or negative voltage sequence for forward and reverse rotation. With contactor *F* closed and contactor *R* opened, *L1* is connected to *T1*, *L2* to *T2* and *L3* to *T3* for forward rotation. With contactor *F* opened and *R* closed, phase 3 is supplied by the secondary of the phase-shift transformer and therefore reversed for reverse drive rotation.

Setup *A* needed four contactors for conventional reversing, but we have now eliminated two of them in this approach to a static system. Therefore, if contactors *F* and *R* of *D* are replaced by equivalent reactors, the result is a completely static reversing scheme, *D*. Full-forward or full-reverse rotation is provided when one reactor is fully saturated and the other not saturated. In addition, intermediate values of reactor impedance can be provided to cause the motor to operate below synchronous speed. This, in effect, gives the motor an adjustable, unbalanced voltage. Since the rotating magnetic field becomes elliptical, torque shows a net decrease. Both reactors are in series with one terminal, so we call this system single-phase primary control.

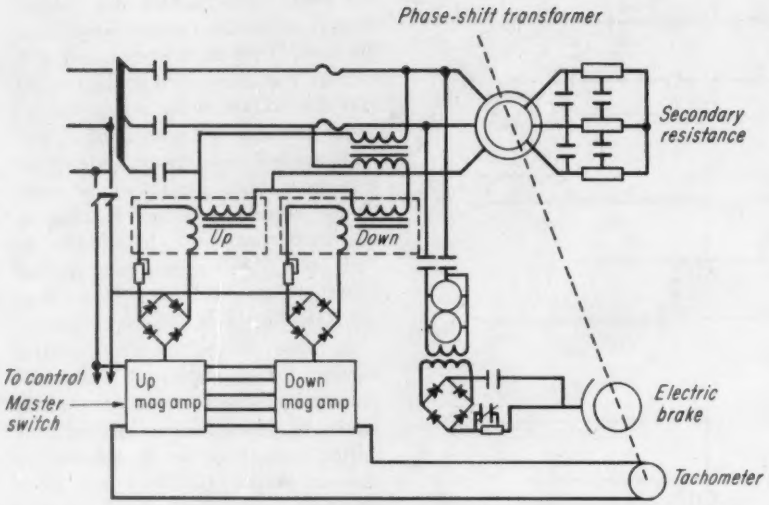
Standard secondary - resistance method of speed-torque shaping can be added to this single-phase 2-reactor primary-control arrangement for increased flexibility, Fig. 4. Secondary resistance is added or subtracted by means of contactors operated from the master switch and speed relays under tachometer feedback control. For example, full resistance adds high torque at zero speed; minimum resistance provides high-torque high-speed operation.

Of course, a master switch position determines secondary resistance, which in turn establishes a speed-torque curve. For any such curve, stepless speed control can be furnished over a wide range—a vernier handles this. In effect, the vernier provides precise stepless direct control current to the primary saturable reactors and thereby varies motor voltage to change speed.

If a dc tachometer is now added to the drive system, Fig. 4, speed can be maintained for any given load and reactor setting. As speed changes, the feedback voltage from the tachometer (compared to the dc control voltage provided by the vernier or master switch) is a corrective for the reactor control winding. Result: reactor saturation changes, affecting primary voltage and motor speed. Speed will stabilize at a point established by the reference voltage, and so it can be changed by altering this voltage.

Hoist moves up and down, simply, with or without loads. But to get all the ramifications of hoisting,

Applied to hoists, 2- and 4-reactor setups give stepless, stable control of speed and better speed-torque characteristics



4 Hoist with 2-reactor control uses dc-tachometer feedback to maintain speed for given load and reactor setting. Contactors are used for rotor-resistance and brake control

the requirements of the motor-control combination are not so simple. For example, the speed at which the motor drives depends both on the amount of load and amount of torque, as well as the direction in which the load is moving. Going down with an overhauling load, the 2-reactor hoist uses no mechanical brakes. Instead, up-torque is applied to the motor to retard the load. So while the motor direction is reverse or down, the torque is up.

For light loads which are not overhauling, reverse torque and reverse motor power must be applied to drive the load down. For heavy overhauling loads, down torque and down motor rotation are applied to lower the load at maximum speed; as a result of the overhauling load, the motor will be driven above synchronous speed as it lowers, and it will operate as a generator which returns power to the lines. Regenerative braking feature limits maximum speed going down.

Another specialized requirement of hoists: they must be able to "inch" or move slowly so that the load can be positioned accurately. Whereas many cranes rely on jogging up and down, applying brakes after each jog, reactor control can use stepless torque, without brakes, to position at slow speeds. The operator can float his load by means of motor torque, and then very slight movement up or down lets him get a precise position.

Speed-torque curves of a typical wound-rotor motor with external secondary resistors are shown in Fig. 5*A*. Full 3-phase voltage to the motor produces a speed-torque characteristic as shown by the solid curve. If two reactors are then inserted in series with one phase and the control current of the hoist reactor varied from 0 to 100% dc, we get speed-torque curves represented by the dotted lines. Varying the direct control current by master switch (variac, rheostat, inductor) or vernier position regulates torque. And so speed-torque curves vary from maximum to minimum.

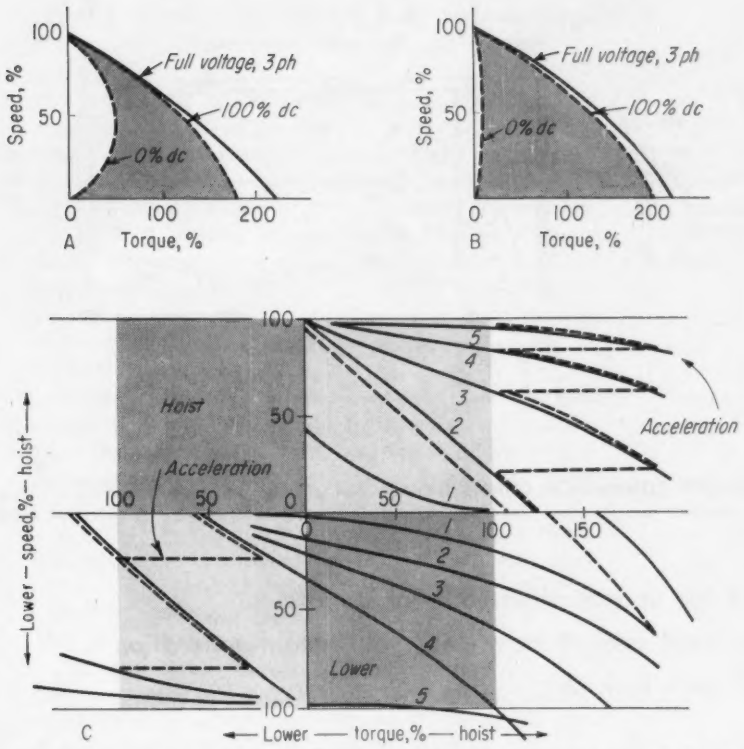
For speed control, torque is changed. Voltage from the dc tachometer coupled to the drive motor opposes the control voltage, automatically reducing the torque when the speed rises or letting it increase if speed drops.

To get different load curves, relative strengths of the forward and reverse reactors are changed by adjusting the control voltage. For greater torque in the forward or reverse direction, contactors change the external secondary resistance. Fig. 5*C* shows typical 2-reactor-control speed-torque curves and accelerations.

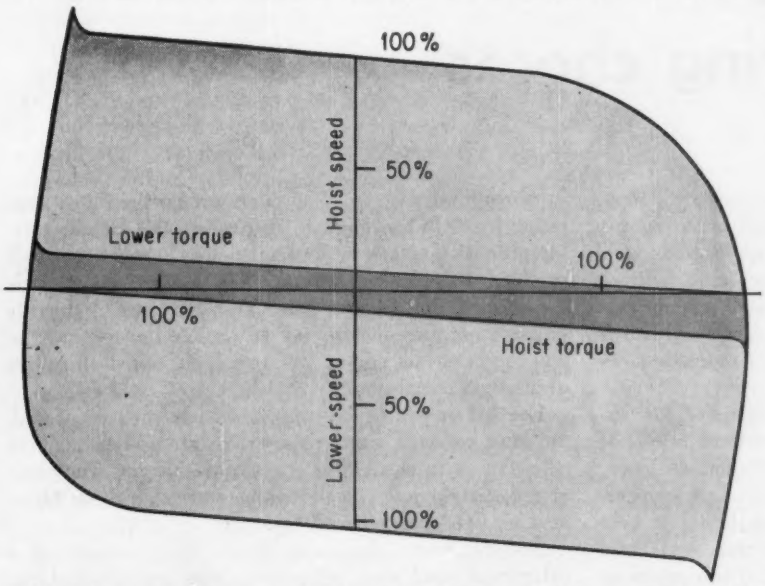
Larger horsepower ratings introduce amplification between the pilot devices (master switch, vernier and pilot generator) and the primary power reactors. When magnetic amplifiers are inserted for amplification or speed regulation, the resulting speed-load curves are essentially flat. But they can readily be adjusted for up to 20% droop to tailor the speed-torque curves to the application.

Basic 4-reactor method of reversing and controlling speed-torque characteristics of wound-rotor motor is illustrated in Fig. 3*E*. It is derived from the 4-contactor setup of 3*A*. Where the 4-contactor arrangement is off-on, the 4-reactor 2-phase method adjusts between full-off and full-on to give subsynchronous speeds.

Direct control current to the saturable reactor is provided by a single-channel magnetic amplifier, whose output is controlled by a low-level-dc signal as established by a master-switch reference and a tachometer-feedback system. Much like the 2-reactor scheme, basic 4-reactor scheme can be built up. But since the 2-phase system is a balanced-voltage circuit, it operates on the principle of reducing primary voltages, while the 1-phase (2-reactor) scheme un-



5 Speed-torque curves are shown for 2-reactor scheme, *A*; 4-reactor scheme, *B*. Complete hoist curves for 2-reactor method include a curve of "hoist" and "lower" accelerations



6 Typical speed-torque curves for 4-reactor hoist control: stepless speed control is provided under full-torque envelope; inching and floating are available in dark band

balances the motor primary voltages.

Secondary control (rotor resistance) is a bonus gained from the essentially balanced voltages of the 4-reactor scheme. Frequency-vs-impedance relationship of a fixed reactor decreases the impedance with the input frequency. Therefore, a reactor produces maximum impedance at 60 cps and minimum impedance at very low frequencies.

Frequency of current in the rotor circuit of a wound-rotor motor depends on the slip. At zero speed, rotor frequency equals stator frequency—60 cps. As the rotor speed is allowed to increase, the frequency will decrease in direct proportion. If these two characteristics are now combined by placing a fixed reactor in the rotor circuit, the change in rotor frequency with slip will change the reactor impedance. Under these circumstances, the so-called fixed reactor functions with variable impedance.

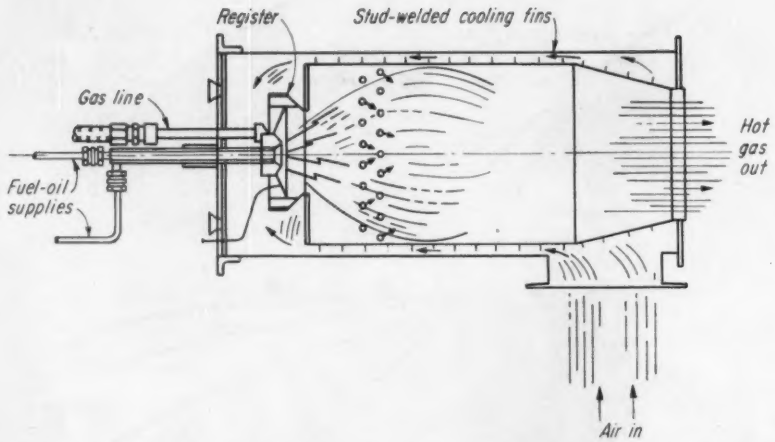
If the fixed reactor is paralleled with a secondary resistor in each phase of the rotor circuit, result is a speed-sensitive control of secondary impedance.

Consider the case of 1.0 slip—zero speed. Rotor frequency and fixed-reactor frequency equal the stator frequency—60 cps. Overall impedance is high, giving high starting torque. As the rotor accelerates and its frequency decreases, overall impedance of the circuit also drops, allowing higher speed at any load.

Typical speed-torque curves for 4-reactor control are given in Fig. 6. Stepless speed control is provided under the full torque envelope. Slow-speed control for inching and load floating is available in the dark band.

Both the 2-reactor and 4-reactor induction-motor control aim to reverse and vary speed-torque characteristics of industrial drives with rugged static components. Reactor control is of significant advantage where you must cope with repetitive operations and frequent reversals, and for cushioned starting and better speed and torque control.

Both controls eliminate reversing contactors, and the 4-reactor scheme also cuts out accelerating relays or contactors. Either system provides stepless speed control (hoist and lower) with smooth acceleration and deceleration; motor braking to stop, hold or float loads without setting hold brakes; stabilized speed and speed regulation with tachometer reference; torque control by terminal voltage and secondary resistance adjustment; fewer trolley collectors than conventional control. The 4-reactor system, however, performs with less heat and better-balanced voltages. It gives a wider speed range and better torque control.



MODERN COMBUSTION CHAMBER design uses techniques first developed for building gas-turbine and jet units. Inlet combustion air helps cool chamber's finned-metal shell

Supplying processes with heated air or gas often calls for variations on conventional combustion-equipment design. How does your steam-generation know-how fit this special service? Let's look at...

How to apply combustion chambers to plant heating chores

Because of their knowledge of combustion equipment, many energy-systems engineers are called on to specify or design fuel-fired heaters for process applications. And this should be right up their alley. Direct- and indirect-fired heaters use the same basic types of combustion equipment that steam generators do. However, a number of details of design and application depart radically from common boiler practice.

In conventional boilers we think in terms of low excess air, high flame temperature and radiant effect. If we achieve these goals we can expect optimum efficiency. But a heater involves very high excess air, and temperature reduction by gas dilution rather than giving up heat to boiler water. To underline the importance of these variations, this article analyzes combustion equipment as it applies to heaters.

Direct-fired heaters can handle many processes which need volumes of heated air for drying, curing, heating and testing—provided the material being processed will not be harmed by contact with the products of combustion. But if the products of combustion can't be tolerated in the air or gas stream, we use an indirect-fired heater of the general type shown on the third page.

Excess air in the combustion stream may run quite high in direct-fired heaters. Very often, air temperatures must range from 400 to 2500 F. Regulating the fuel-air ratio to agree with values shown in the chart, lower right, will produce desired temperatures. A warning: this chart is constructed for a given fuel. You can't use it directly unless your own fuel supply is similar in makeup. But you can construct curves for other fuels, based on results of proximate analysis.

For oil or gas firing with a constant makeup of fuel, the most common way to test excess air and combustion efficiency is to check CO_2 content of exit gas. The chart at upper right lets you determine excess air from Orsat or other CO_2-analyzer readings.

Simplest heater design for direct firing consists of a cylindrical steel shell, refractory lined and fitted at the firing end with rotary or low-pressure air-atomizing oil burner. For gas firing, ring or premix burners are popular. These furnaces require between 0.1 and 4.0 in. H_2O of draft to induce the necessary air volume through the furnace.

Today's processes demand higher capacity and efficiency from their heaters. To achieve these design goals we apply principles recently developed for gas-turbine and jet-engine combustion chambers. The philosophy is to use

By M E PROWLER, Products Div, Todd Shipyards Corporation

blowers capable of furnishing the total weight of air required. Part or all of this air is directed down the length of the combustion chamber. Many installations use counterflow air stream: portion of the air not needed for combustion bleeds into the combustion chamber *after* the point of ignition, drawing, above left. An alternate design introduces total air weight at the front of the unit. Quenching or "diluent" air travels between shells and enters gas stream at chamber outlet. Split ducting and control dampers permit variations in the ratio of combustion air to total air.

Split-air-flow operation serves two important purposes. Inlet air is used to cool the furnace liner and the outer shell of the heater. In the course of performing this important function, the air is preheated—a big assist toward the goal of complete and rapid combustion.

Air flow's cooling effect reduces convection and radiation losses. In many cases, the double-shell arrangement can be used without needing a refractory chamber lining —that is, when operating temperatures remain below 1800 F at the outlet, firing gas or light oil.

For temperatures over 1800 F or for firing No. 6 oil, most engineers find refractory furnace linings an economic necessity. Metal combustion chambers can be used at higher temperatures, provided the inlet air is under high pressure and has correspondingly high density.

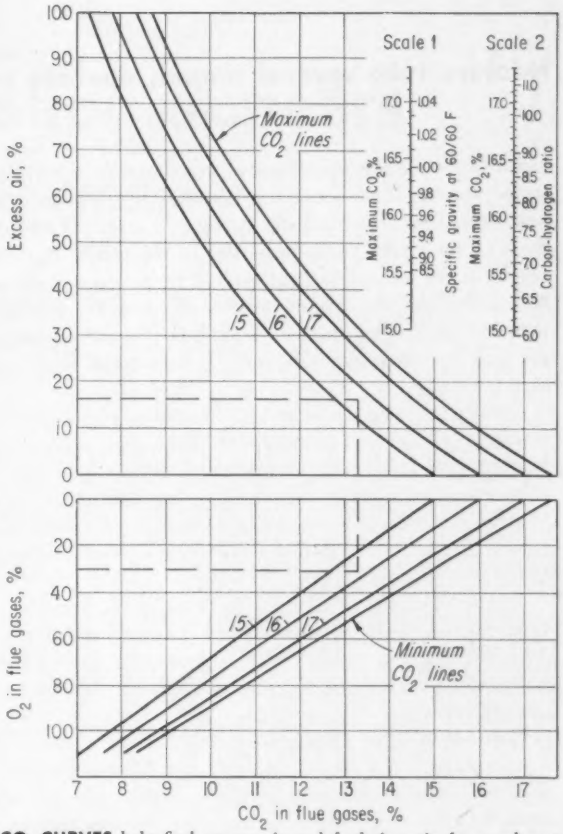
A third design does *not* introduce additional air through ports in interior shell. Instead, it adds this air to the gas stream leaving the chamber, as shown in the dryer on next page. Diluent is balanced with combustion air to obtain the desired air quantity and temperature.

Blowers sized to overcome pressure drop through the combustion chamber can be fitted to the direct-fired air heaters outlined above. Heaters then can be arranged to discharge into a negative-draft, balanced-draft or pressure environment. They also can be made to operate with air pressures as high as several hundred psig.

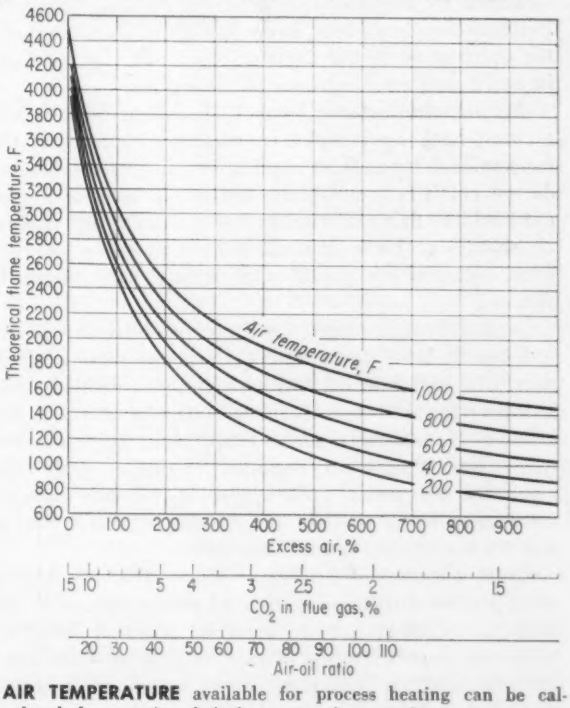
Heat-release figures for modern combustion chambers are a function of the fuel you fire. Burning gas or light oil, a properly designed chamber can release heat at a rate of 1-million Btu per cu ft. Heavy oils burning in a refractory-lined furnace normally drop the heat release to about 250,000 to 400,000 Btu per cu ft.

Whether or not you'll decide on direct-fired units depends on specific application. The combustion chambers are readily installed to discharge vertically—upward or downward—or horizontally. Under these circumstances, discharge ductwork stays at a minimum. Vertical installations discharging into flash dryers may take the form shown on next page. Similar ones are used for drying soluble foods and processing substances such as liquid soaps and chemicals into powdered form.

Indirect-fired heaters bring their own set of problems. Most gases and many liquids have low coefficients of heat transfer. So to heat them indirectly, you must use a method that does not involve dangerously high tube-metal temperatures. One very effective way to accomplish this generates the required volume of hot gases in a high-



CO_2 CURVES help find excess air and fuel-air ratio from exhaust-gas analysis and your knowledge of specific makeup of your fuel



AIR TEMPERATURE available for process heating can be calculated from ratio of fuel to air plus supply-air temperature

Heaters take several shapes, operate in any position

heat-release combustion chamber at accurately controlled temperatures. These gases are directed across a tubular heat exchanger. Heat-transfer surface is arranged so that there is no direct flame radiation to the tubes. For example, if we wanted to heat asphalt to a temperature of 400 F leaving the heater we would need an inlet-gas temperature around 1500 F. Then it is possible to design the unit so maximum tube-metal temperature won't exceed 600 F.

Circulating rate is a most important factor in controlling tube-metal temperature. However, convection heating can keep tube temperatures within safe limits at reasonably low velocities through the tubes. This same principle applies whether you're heating air or other gases. The air heater below right demonstrates this type of indirect heat exchanger.

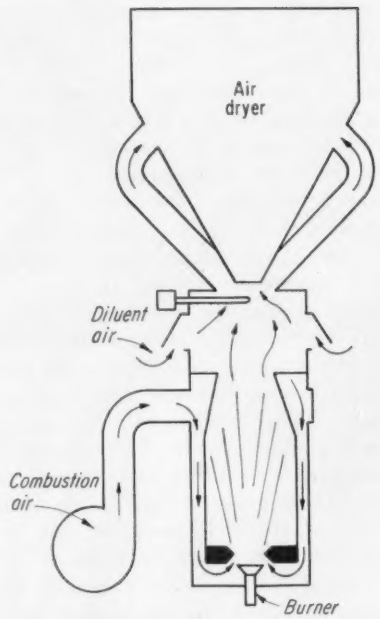
Radiant heating is all right in some cases, provided a very high velocity is maintained through the heater. At low velocities, radiant heating leads to repeated tube failure because radiant transfer is too large a portion of overall transfer.

Control-system design depends upon process dynamics as well as characteristics of your heater. For most applications, diluent-air-to-combustion-air ratio is controlled by fixed orifices or manually controlled dampers. Total air flow is adjusted so it responds to load variations as sensed by thermocouples at dryer outlet, or product-feed-rate signals. In most cases, additional controls monitor overheating in the combustion chamber proper and in outlet duct after entrance of diluent air.

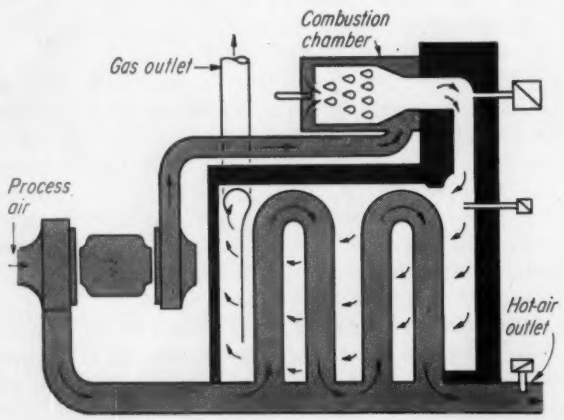
Automatic start-stop controls, including flame-failure sensors, back up complete combustion controls of the conventional type. Most applications in process heating do not entail fully automatic startup—process operators must initiate firing. But safety has the overriding control of shutdown. These controls usually function as run-back, followed by shutoff after a final safety limit is reached.

Control dynamics need kid-glove handling to squeeze full benefit from these heaters. Designers must keep in mind that high-heat combustion chambers, including the indirect type of convection heater shown at right, are capable of extremely rapid temperature response. Because these designs use minimum refractory, little heat saturation will occur. So temperature responds immediately when firing rate changes, permitting rapid startup and an almost equally rapid shutdown.

Rapid response of the heater places greater emphasis upon process dynamics and control-system operation. All temperature measurements must be taken at locations which will supply the first possible indication of the need for control action. Locations should be left up to heater manufacturers—with some added advice from you.



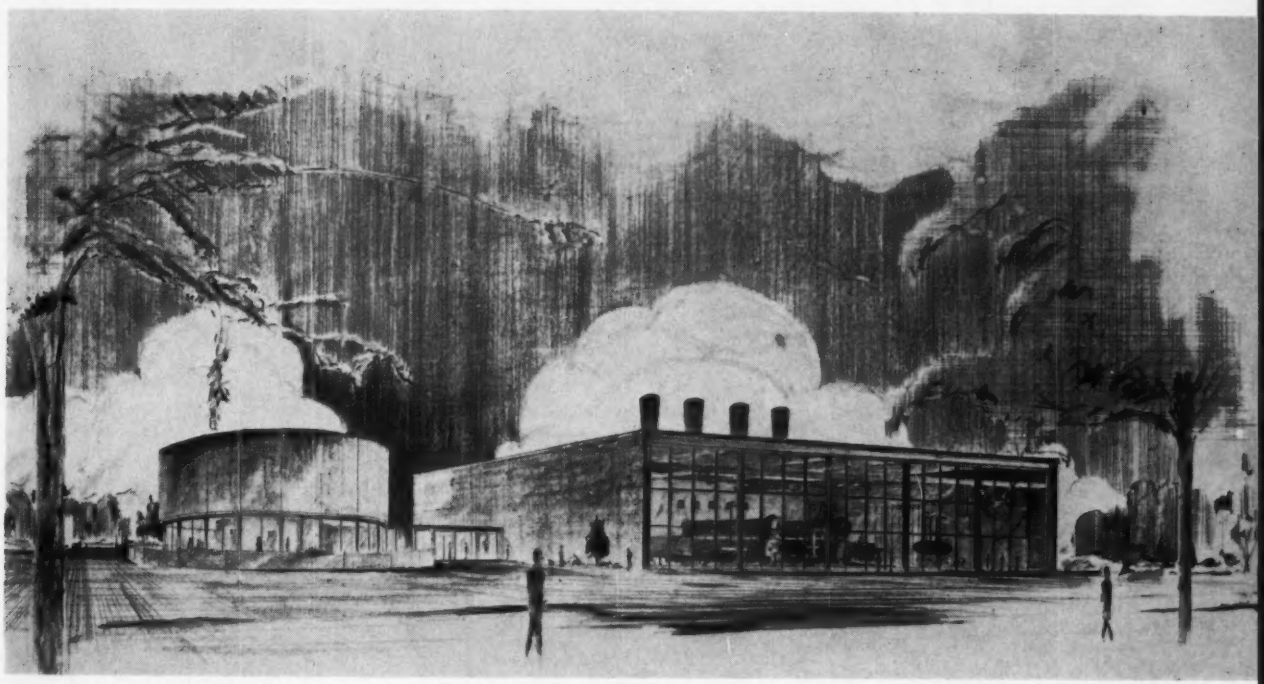
VERTICAL FLASH HEATER depends on combustion air for chamber cooling. Diluent air is pulled in by draft at exit of the unit



INDIRECT HEATER places combustion chamber above heating area. Convection transfer keeps tube from overheating by radiation

Hartford Gas Company plans its new central-station cooling and heating plant to support a massive urban-renewal project

Centralized refrigeration appears as a public-utility service



SHOW-PLACE POWER PLANT will supply steam heat and chilled water for Hartford, Conn.'s Constitution Plaza and nearby buildings

As early as 1940, Willis H Carrier dreamed of centralized air conditioning as a public utility service. Some 21 years later, the dream is coming of age in Hartford, Conn., as the Hartford Gas Co prepares to put a $3-million central plant into operation in 1962.

Today, many utilities are taking a close look at cooling as a promising market for growth. So POWER went after a rundown of plant design and put together the facts on the how and why of current utility cooling plans.

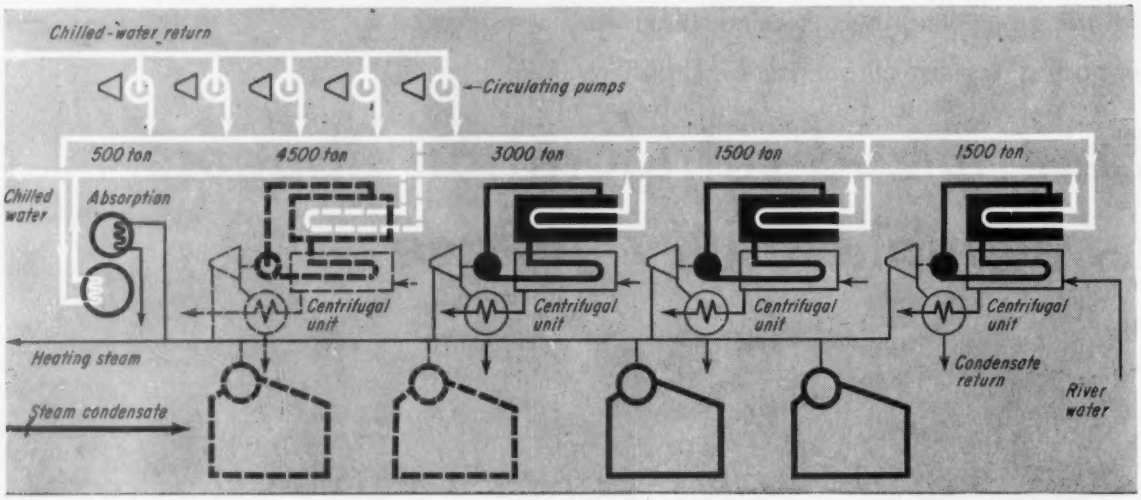
The Hartford story is a prime example of long-range planning for city modernization and expansion, and a utility's efforts to anticipate future needs. Coming off the drawing board: a 3-step program to redevelop the heart of the city. Step 1, Constitution Plaza, is already going up — an area including five major buildings. At the same time F H McGraw Company, general contractor for the Plaza, is building the distribution system and show-place power plant, above, for the Hartford Gas Co.

This plant will send heating steam and chilled water to control the climate of all buildings in the Plaza and some other nearby buildings. In its own first stage of growth the plant will have an installed capacity of 150,000 lb of steam per hr and 6500 tons of refrigeration. Later expansion within the power plant will double steam-generation capacity and add up to 4500 tons of refrigeration. Engineers from Carrier Air Conditioning Company worked closely with the gas company and their consultants at all stages of planning.

Heating and cooling load comes from multistory office buildings with high population density. Decision to service existing buildings outside the Plaza approximately doubled initial requirements of the power plant. Between the cooling demands of several large computer installations and interior office spaces which must be cooled all year 'round, engineers figured a continuous supply of chilled water would pay off.

Existing buildings and new construction call for steam heat. This,

Centralized, steam-operated plant boosts efficiency but must



PLANT CYCLE is designed to make maximum use of plant steam for mechanical drives as well as heating load. All rotating machines—compressor drives, circulating pump, feed pump and fan drives—use m-d turbines. Dotted lines show future equipment

and the need for simultaneous heating and cooling, dictated a power plant which could send steam and chilled water through parallel systems. Consequently, plant designers elected a steam cycle to supply heat and drive other equipment.

Plant cycle, shown above, uses steam as the major energy source throughout. Steam generated at 125 psig feeds a header system which sends steam to the utility mains and to refrigeration units. Condensing steam-turbine-drive compressors produce the bulk of refrigeration—6000 tons initially and 10,500 tons to come.

A 500-ton absorption unit was to be part of Stage 2, but as planned use expanded it was rescheduled for Stage-1 installation. This unit represents minimum anticipated cooling load for the plant—during extremely cold weather the cooling load should drop to the 500-ton range, and at that time all centrifugal compressors will be out of service.

Condensing cycle for turbine drives was selected after analysis of anticipated load curves. Because of the high turndown ratio expected, pickaback cooling — steam-turbine-driven centrifugal in series with absorption unit fed by turbine exhaust—could not be justified. Condenser losses were more than offset by the better part-load water rate of the steam-turbine drive.

Plant auxiliaries follow through on the steam-cycle drive wherever possible. Chilled-water circulating pumps, condensate-return pumps, boiler-feed pumps, boiler fans and fuel-oil pumps all have steam-turbine drives. Fans, boiler-feed and fuel-oil pumps have some motor drives in parallel for startup and emergency. The motor drives can also be used to bring the overall heat balance back in line with deaerating-heater requirements and thereby prevent waste of steam-turbine exhaust. However, operating cost of the motor drives dictates that they be used only for the purposes outlined above.

Design steam flow for maximum cooling load: approximately 225,000 lb per hr. This means the ultimate plant will have reserve capacity of about 75,000 lb per hr with all boilers running. One boiler is then a spare.

Heating load comes from the proposed Constitution Plaza plus two large insurance office buildings nearby. Initially, this will amount to about 102,000 lb of steam per hr. Potential business—including both new and existing buildings located along the lines to the Plaza—will let them almost double this service.

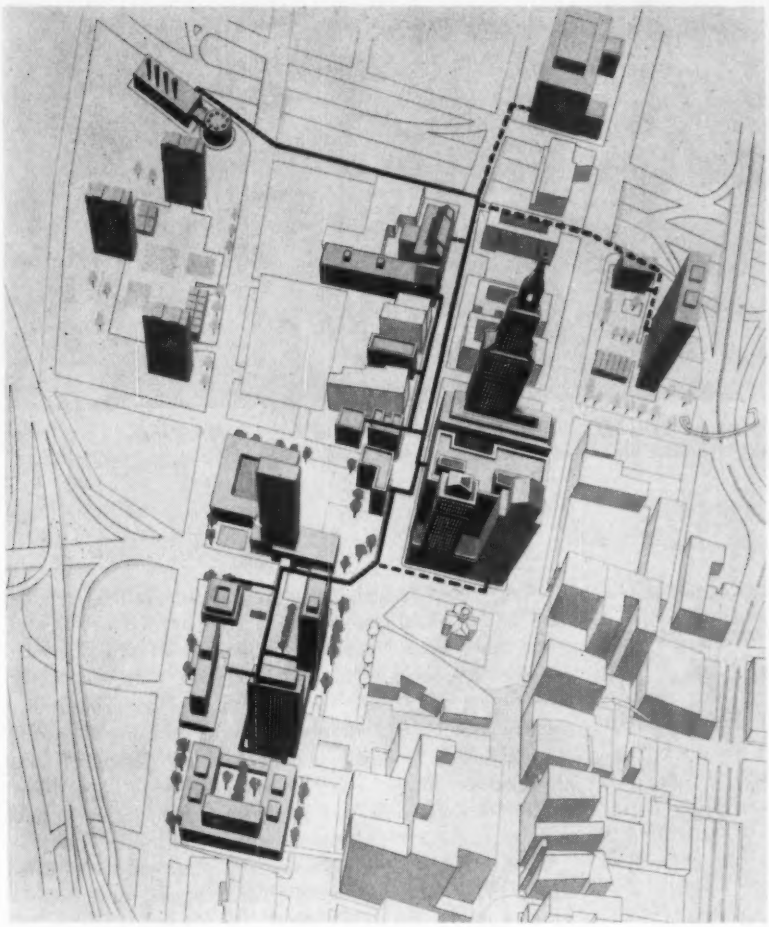
Operating advantages for The Hartford Gas Company accrue from two factors: opportunity to supply another service to their customers in what appears an important growth market, and a chance to balance summer-winter gas-consumption rates. This second problem has plagued utilities for years—to get an idea of just how serious it has been, let's examine a few statistics.

During the winter of 1960-'61, Hartford Gas Co's purchase contracts required them to buy 26,000,000 cu ft of gas a day. Their peak day was 32,000,000 cu ft, the difference being made up from storage facilities. Last summer, with virtually no heating requirement to fill, gas output was only 7,400,000 cu ft per day. But the company still had to take, or pay for, 18,000,000 cu ft because, in general, the same amount of natural gas must be purchased from the transmission companies each day of the year.

With the plant in operation, and a known and expanding cooling load to meet, the gas company will be able to even out that summer valley. Also, by improving their overall load factor they will better their purchasing position on the natural gas.

Relative economics of central-

concentrate its load to trim piping costs



COMPACT LOAD AREA permits high capacity per unit length of transmission pipes. Future spur lines along dotted paths will feed housing groups, other office buildings

ized utility cooling worked out in favor of the Hartford plan. But many utility men ask themselves just how, and under what conditions, utility cooling would pay off in other cities. To get the answers to some of their questions we went to the consulting engineers for the Hartford project, Seelye, Stevenson, Value and Knecht. Eric Roos, partner in the firm and expert in this area, set out some ground rules for successful centralized utility cooling. First and foremost, such a plan must be based on fairly heavy cooling loads concentrated in a small area, because transmission costs are such a big factor in centralized systems.

Piping systems for the Hartford plan appear in the aerial view above. Since this plant supplies both steam and chilled water through closed-loop systems, the black line represents four individual pipes. Chilled-water supply and return lines are 24-in. dia. The steam-supply line will be 12-in. piping and the return line will have a diameter of 5 in. All lines will be underground and all except the chilled-water return line will be insulated. Entire system will be cathodically protected.

Just counting the solid lines shown above, each pipe will run about 3600 ft. Total system length: about 14,400 ft. This piping system eats up a big chunk of overall plant cost, so the longer the piping lines, the greater the cooling load must be to pay for the system. Cost factor is compounded by operating problems which often go with return-loop systems: steam condensate may be extremely corrosive and contamination of both returns by customers is a major headache. The utility may end up with costly alloy return lines, extensive water treatment or both.

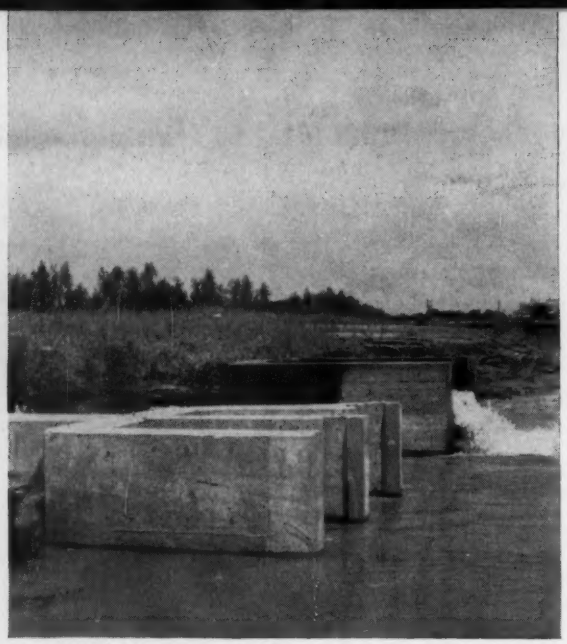
Plant-cycle selection becomes an important aspect of system economics. The prime reason for the central plant is the opportunity for larger, higher-efficiency systems. But size of individual units must dovetail with cooling-load-range requirements. Excessive spare capacity costs money, yet the system must be designed at present so loss of one refrigerating machine or boiler won't reduce capacity below acceptable limits.

More-efficient cycles are possible in the central-station heating and cooling plant. However, cycle efficiency at part loads may be such that it doesn't pay to adopt more complicated cycles just to save a few Btu's at full load. Final choice of a cycle must depend on a careful and accurate analysis of anticipated load curves.

The future of centralized utility cooling systems rests with the modernization of our urban centers. Housing developments, office areas, hotel and store groupings all offer an excellent market for profitable cooling service. As loads grow, we can expect to see machines up to 5000-tons capacity, and compressors driven from the shaft of a large turbine-generator may appear at in-city stations. Alternate designs apply the topping turbine, with exhaust going to turbine drives of centrifugal machines. To complete the picture, exhaust of turbine drives could feed to absorption machines in summer, heating systems in winter. Another possibility is the use of gas turbines as a prime mover. If satisfactory lightweight machines are developed they may find widespread future use.

Designs are practically unlimited, and for utilities with the right combination of conditions, opportunities for vastly expanded air-conditioning services are equally unlimited.

UNNECESSARY OVERFALL wastes five ft of pumping head. In a low-head circulating-water system, this added cost can run high



TURBULENT DISCHARGE in rear wastes energy. Better seal-well design, foreground, discharges more water with no turbulence

Just one extra foot of head can cost 1800 kwhr daily in a large generating-station cooling-water system. And needless hydraulic losses as high as 20 ft have been found. So to cut operating costs . . .

Design hydraulic efficiency into large condenser cooling-water systems

By R T RICHARDS, Burns and Roe, Inc

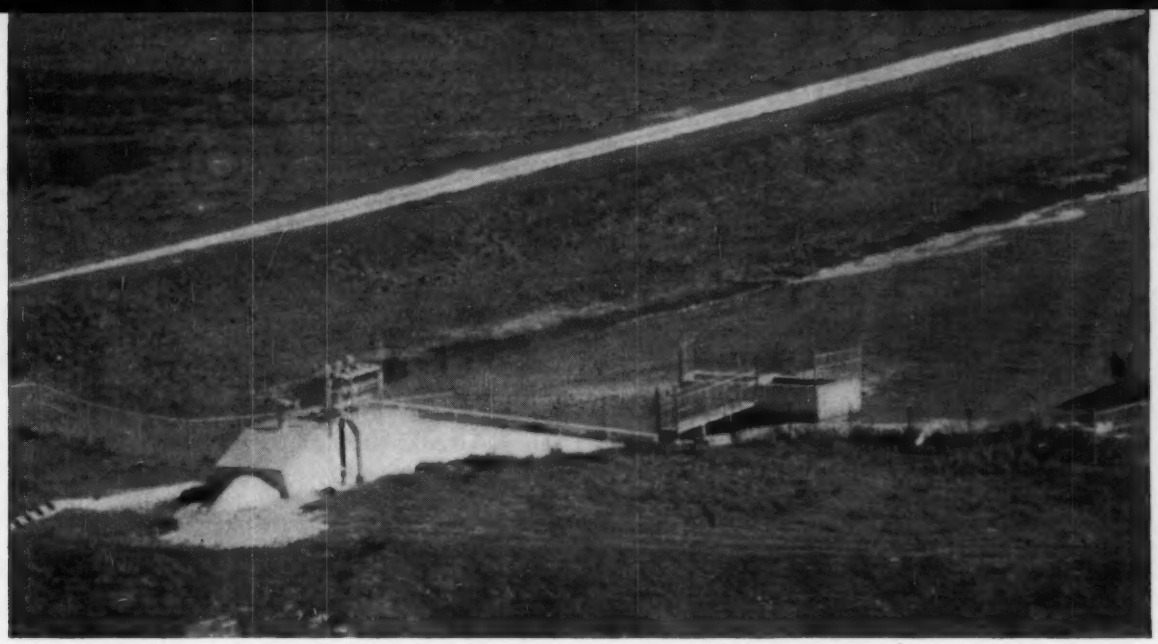
Cooling-water systems in large central stations handle tremendous quantities of water. By way of comparison, one recently constructed power plant in a large Southern city uses ten times as much water as the rest of the city does for all other purposes. Operation of these large circulating systems is a significant part of overall plant costs.

Total heads against which circulating pumps operate are relatively low—25 to 35 ft is common. So the adverse effect of a mere one ft of excess total head is magnified and represents a high proportion of total power needs.

Circulating-water systems are often grossly overdesigned. Designers are guilty of using friction factors which apply to small but not to large pipes, and adding "safety" margins which may be appropriate for complex water-service piping, but have no place in circulating-water-system design. Take a closer look at hydraulic assumptions to be sure that you are not wasting power and money, and very possibly overdesigning to the point of decreasing condenser and pump life.

One of the best ways to start this closer-look approach to circulating-water-system design is by reviewing existing plants. From the errors and excessive margins all too frequently found, you can recognize pitfalls and determine the most economical design for your particular job. If your responsibility is not design but operation, a close look at your circulating-water system may turn up many ways to improve hydraulic efficiency.

The seal well is the best place to start. In fact, it coincides with the beginning of your hydraulic design. Is the water flowing over a weir to some lower level? If so, this may represent unnecessary loss. The 5-ft fall, above left, amounted to an unnecessary 5-ft lift of the entire circulating flow. It was created by leaving stop logs in place. Originally, they had been installed to force warm water into the winter ice-control recirculation system. In this particular case they were left in place for experimental aeration, but it is not unusual to find that operators just forget to remove the logs when recirculation is no longer



SLOPING DISCHARGE PIPE over a flood dike is protected against air binding. Vents are located all along the downstream pipe, headered to an air-removal system. This assures complete air removal at any point in the pipe, no matter where bubble forms

needed. Even if this is only one or two ft of unnecessary fall, it should be eliminated if possible.

The purpose of a weir at seal-well discharge is to maintain water level so that the workable height of the siphon in the system is not exceeded. But this height is a variable; it changes from plant to plant. Usually it is the height beyond which an accumulation of gases cannot be removed economically. Years ago, 20 to 25 ft was considered high even for a sea-level plant. Today, many plant designers consider 30 ft practical.

But what height is right for your plant? One good way to be sure to get it right in operation is to set the permanent crest several feel below the elevation at which you feel you can get maximum practical siphon. Then use removable stop logs to make up the difference. This permits experimentation by the plant operators; they are not locked into a design that isn't optimum.

The water surface of a seal well in operation is frequently a clue to good or poor design. The two outfalls in center photo make a good contrast. Turbulence in the older and poorer design in rear kills off several feet of head—a definite waste. Flared interior sidewalls of the foreground structure slow the flow gradually. They pay off because there's no loss through turbulence. And in this picture, the smooth-flowing foreground seal well is actually discharging more water!

Next, a review of hydraulic gradients, actual vs design, will point up locations where improved hydraulics could have paid off or can be made to pay off in an existing station. The design hydraulic gradient which should be on file for every job will look something like the sketch on next page. Areas of planned vacuum are shown. If such a design gradient does not exist for your review installation, it's a relatively simple matter to draw one up. Take a profile sketch of the cooling-water system and draw the theoretical-friction-losses line using the vertical scale of the profile as your head coordinate (in feet). You may have trouble getting accurate flows for friction calculations—this is a major problem with large water quantities. But you can usually get a reasonable approximation by using pump manufacturer's curves to find flow corresponding to a specific pump discharge pressure. Be sure to take into account the vertical elevation of your gage.

Then compare design gradient to actual field pressures throughout the system. You may be surprised at the differences you find. These differences are clues to possible savings; they show places where your new design might avoid errors in the review design—and they may well show operators where correctable excess-head losses are concentrated—places where they should take a closer look.

We've already mentioned conservative design and margin. Here's where these two factors—and their cumulative effect—really show up. Original system design for condenser, valves and piping more than likely had a fudge factor in it—something to allow for inaccuracy in design parameters. This is conservatism. The pump manufacturer probably built the pumps a little strong—capable of slightly more head than guaranteed. This is margin. These two factors combine to increase flow and system velocity beyond actual design, an increase which usually does no useful work and may reduce condenser-tube and circulating-pump life because it accelerates erosion.

Your system check will show up these factors. But don't be fooled by comparing just total values. Excess undesirable head losses in the piping may be balanced off by low losses in the condenser. The total may look right, but conduit losses are nevertheless excessive, perhaps because of air-binding or fouling. So it is certainly worthwhile to track down causes for apparently local high head losses, even if total friction drop and pump output seem to come close to your design hydraulic gradient.

Excessive piping loss is often the result of less-than-full flow, even though the piping system may be effectively sealed at the end. This is air-binding. It frequently happens in piping that slopes downward in the direction of flow. It may occur in level pipes as well, as shown in the

partial system sketch below, right. Actual hydraulic gradient exceeds theoretical by a distance equal to the head loss in ft. This head loss is directly reflected in reduced flow, reduced efficiency and possibly in the use of more pumps than should be needed for a particular plant load and water-source temperature. Cure: use air-removal equipment at suspect points in the system to assure full piping throughout. Air take-offs should be located near the end or high point in the piping and along downward slopes to be sure to remove all the air. The 90-in. siphon discharge pipe going over a river dike, p 75, shows a satisfactory system of vents along the slope.

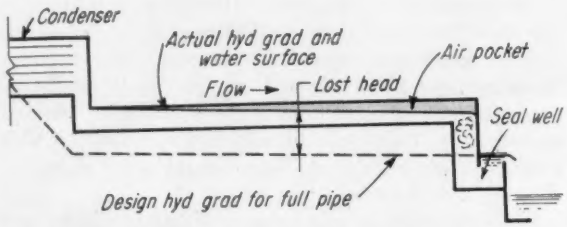
Check possible condenser troubles next. Fouling, scaling and clogging increase losses and cut flow. Tube erosion may result from velocities higher than design—conservatism plus margin—combined with abrasive solids. But this part of a cooling-water system is usually closely followed by operators, so these troubles don't long go unnoticed; when detected they are promptly fixed.

Finally we come to the pump itself. Vertical wet-pit condenser circulators are particularly sensitive to flow patterns entering the impeller. Unequal water distribution may induce cavitation, result in vibration and pitting. But unless conditions are very poor, the pump may not show excessive wear for years. The point is, how many years? If the impeller fails in six months or a year, there is obviously something very wrong—both designer and manufacturer will get complaints. If excess wear occurs over two or three years, however, operators may chalk it up to normal wear and tear and handle the problem as standard maintenance. But impellers should last many years—10 to 15 years is not unusual—so anything less should be suspect.

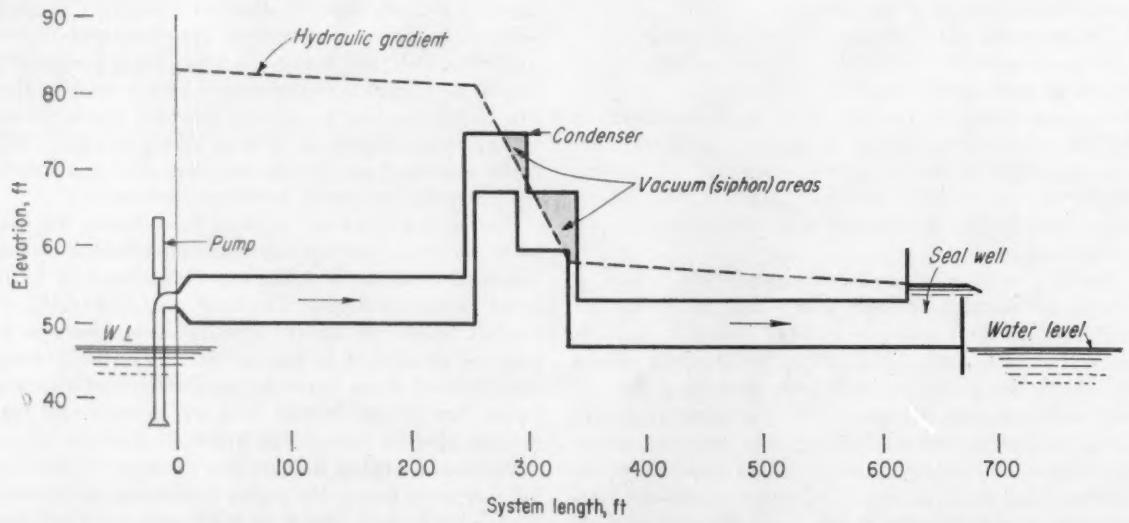
First place to look for pump troubles is the suction chamber. Manufacturers have made extensive studies of just what is a proper chamber and they are prepared to offer advice. A good check: observe operation. Do vortexes form? If they draw air into the pump it will undoubtedly be noisy; then you know you have suction-chamber troubles. Where several pumps operate in parallel serving one condenser, it is often economical to shut one or more pumps down at light load. All too frequently, pumps are left on when not needed. This wastes power. The check here is to determine actual needs of cooling-water flow vs water temperatures. Then set up operating procedures to suit.

Greatly oversized pumps can get into trouble and you may not know about it until damage is already extensive. Circulators are usually designed to operate at a set pressure and flow. While there is some range here, there are also definite limits. Beyond maximum flow, submergence needs often rise sharply—well beyond physical possibilities. An oversized pump may well run out beyond this range with resultant cavitation and damage.

A check of these real and potential operating problems in an existing plant serves two valuable purposes. First, you may be able to increase operating efficiency in the plant itself. Second, findings will guide future hydraulic design so the same faults won't be perpetuated.



SIPHON DISCHARGE, unless it's vented, can trap air. Then actual hydraulic gradient is higher than design, increasing head



HYDRAULIC GRADIENT, superimposed on cooling-system profile drawing, shows design pressures throughout the circuit. Compare these values with actual pressure readings to find areas of abnormally high loss. Then check the system for air binding or fouling

Thermodynamic properties of sodium and its vapor

Available data on sodium is scattered—and it's not always in agreement. But here is a compilation of experimental data knitted together with theoretical calculations believed to be accurate enough for most design uses

By E L DUNNING, Associate Professor of Applied Science
Southern Illinois University

Sodium has become an important heat-transfer medium in power and process plants. To speed the design of equipment, this article tabulates data on the thermodynamic properties of liquid and vaporous sodium. Table 1, next page, gives data on saturated sodium liquid and vapor and table 2 on p 79 gives data on superheated sodium vapor. A Mollier chart, p 80, illustrates the variation of properties listed in the tables.

These properties are not complete, but their scope makes them useful in designing heat-transfer equipment.

Vapor-pressure data. Several empirical equations have been derived for relating vapor-pressure data of sodium. Published data on these have been inconsistent. Equation (1)[1] has been chosen as the most reliable:

$$\log P = -10{,}021/T - 0.5 \log T + 8.149 \quad (1)$$

where P is in psia and T in degrees Rankine. This equation gives a normal boiling point of 1618 F. Another equation[2] in two parameters gives about the same boiling temperature:

$$\log P = -9396/T + 5.688 \quad (2)$$

But equation (2) assumes that the latent heat of vaporization is independent of temperature. This is not so, as we'll show later.

Dimerization. Sodium vapor is monatomic at normal temperature and dimerizes to Na_2 as the temperature rises. The reaction is: $Na + Na = Na_2$. Property values in the table and chart account for the dimer. The quantities were evaluated on a mole basis and then divided by the molecular weights.

Molecular weight is proportional to the amount of dimer in the mixture and may be figured as:

$$M_m = X_1(M_1) + X_2(M_2) \quad (3)$$

where M_m = molecular weight of mixture
M_1 = molecular weight of component 1
M_2 = molecular weight of component 2
X_1 = mole fraction of component 1
X_2 = mole fraction of component 2

In these calculations, molecular weights of Na and Na_2 were taken as 23 and 46 respectively. The mole fractions were calculated by using these equations [3]:

$$Kp = PNa_2/(PNa)^2 \quad (4)$$

where Kp = equilibrium constant
PNa_2 = partial pressure of Na_2 vapor
PNa = partial pressure of Na vapor

and $N_1 = 1/(1 + 0.272P_tK_p)$ (5)

where N_1 = moles of Na vapor at equilibrium
P_t = total pressure, psia

also, $X_1 = 2N_1/(1 + N_1)$ and $X_1 + X_2 = 1$

Values of PNa and PNa_2 were found in the literature [4] for the range of 208 to 2050 F. Beyond this range, extrapolated values for K_p were used.

Specific volume was determined from the density-temperature relationship. Equation (6) below [4] was chosen as being sufficient for density evaluation of liquid sodium:

$$d = 59.47 - 0.0077t - 3.48 \times 10^{-7}t^2 \quad (6)$$

where d = density, lb per cu ft
t = temperature, F

Specific volume of the vapor was determined by using the perfect-gas equation and applying the compressibility factor z:

$$pv = zRT$$

Factor z was found from the generalized compressibility charts using 4091 °R and 5050 psia as the critical temperature [3] and pressure respectively.

(Turn page for Na tables. Story continues on p 80)

[1]Superscript numbers refer to bibliography at end of article

1—Thermodynamic properties of sodium, saturated phases

Temp, F	Pressure, psia	Volume		Enthalpy			Entropy		
		V_f, ft³ per lb	V_g, ft³ per lb	h_f, Btu per lb	h_{fg}, Btu per lb	h_g, Btu per lb	s_f, Btu per lb, °R	s_{fg}, Btu per lb, °R	s_g, Btu per lb, °R
208	16.8×10^{-10}	0.01726	18.53×10^{10}	0	1964	1964	0	2.9407	2.9407
250	15.02×10^{-9}	0.01736	21.98×10^{9}	13.85	1962	1976	0.0201	2.7633	2.7834
300	1.07×10^{-7}	0.01749	32.96×10^{8}	30.20	1961	1991	0.0423	2.5802	2.6225
350	7.44×10^{-7}	0.01762	50.45×10^{7}	46.40	1952	1998	0.0629	2.4099	2.4728
400	37.52×10^{-7}	0.01775	10.59×10^{7}	62.45	1943	2005	0.0821	2.2593	2.3414
450	16.59×10^{-6}	0.01788	25.36×10^{6}	78.35	1933	2011	0.1000	2.1241	2.2242
500	51.50×10^{-6}	0.01801	8.576×10^{6}	94.10	1924	2018	0.1168	2.0041	2.1209
550	17.45×10^{-5}	0.01818	26.52×10^{5}	109.80	1913	2023	0.1327	1.8940	2.0267
600	52.00×10^{-5}	0.01829	9.298×10^{5}	125.40	1902	2027	0.1478	1.7944	1.9421
650	13.00×10^{-4}	0.01843	38.78×10^{4}	140.90	1890	2031	0.1621	1.7027	1.8648
700	3.05×10^{-3}	0.01858	17.18×10^{4}	156.30	1880	2036	0.1757	1.6207	1.7964
750	6.72×10^{-3}	0.01871	8.072×10^{4}	171.60	1864	2036	0.1886	1.5404	1.6683
800	14.30×10^{-3}	0.01886	3.921×10^{4}	186.85	1849	2036	0.2009	1.4674	1.6135
850	27.82×10^{-3}	0.01901	2.081×10^{4}	202.05	1835	2037	0.2127	1.4008	1.5629
900	53.40×10^{-3}	0.01916	1.118×10^{4}	217.20	1821	2038	0.2240	1.3389	1.5158
950	94.10×10^{-3}	0.01931	6592	232.30	1806	2038	0.2349	1.2809	1.4728
1000	0.1662	0.01947	3801	247.35	1792	2039	0.2454	1.2274	1.4329
1050	0.2740	0.01963	2367	262.35	1778	2040	0.2555	1.1774	1.3961
1100	0.4280	0.01978	1555	277.35	1764	2041	0.2653	1.1308	1.3617
1150	0.6575	0.01995	1037	292.35	1750	2042	0.2748	1.0869	1.3298
1200	1.012	0.02011	689	307.35	1736	2043	0.2840	1.0458	1.2999
1250	1.489	0.02029	479	322.35	1722	2044	0.2929	1.0070	1.2714
1300	2.120	0.02045	344	337.35	1707	2045	0.3015	0.9699	1.2453
1350	3.060	0.02064	243	352.40	1693	2045	0.3099	0.9354	1.2203
1400	4.275	0.02081	178	367.45	1678	2045	0.3181	0.9022	1.1978
1450	5.855	0.02100	132	382.55	1665	2048	0.3261	0.8717	1.1777
1500	7.880	0.02118	100	397.70	1654	2052	0.3339	0.8438	1.1585
1550	10.18	0.02137	79.1	412.90	1642	2055	0.3416	0.8169	1.1408
1600	13.28	0.02156	62.0	428.20	1631	2059	0.3491	0.7917	1.1345
1618	14.70	0.02170	56.1	433.70	1626	2060	0.3519	0.7826	1.1233
1650	17.12	0.02181	48.8	443.55	1618	2062	0.3565	0.7668	1.1072
1700	22.00	0.02203	38.6	459.00	1606	2065	0.3637	0.7435	1.1072
1750	27.82	0.02225	31.14	474.55	1594	2069	0.3708	0.7212	1.0920
1800	34.42	0.02247	25.60	490.20	1584	2074	0.3778	0.7009	1.0787
1850	42.72	0.02271	20.99	505.95	1576	2082	0.3847	0.6823	1.0670
1900	52.05	0.02299	17.52	521.85	1567	2090	0.3915	0.6639	1.0554
1950	63.87	0.02317	14.52	537.80	1557	2095	0.3982	0.6461	1.0443
2000	75.75	0.02341	12.44	553.90	1546	2100	0.4048	0.6285	1.0333
2050	91.02	0.02372	10.31	570.15	1538	2108	0.4113	0.6128	1.0241
2100	107.23	0.02393	8.796	586.50	1530	2117	0.4177	0.5977	1.0154
2150	127.18	0.02919	7.457	603.00	1524	2127	0.4241	0.5839	1.0080
2200	147.29	0.02446	6.537	619.60	1518	2138	0.4304	0.5706	1.0010
2250	170.96	0.02474	5.719	636.30	1513	2149	0.4366	0.5583	0.9949
2300	198.45	0.02503	4.947	653.15	1507	2160	0.4428	0.5460	0.9888

These thermodynamic properties

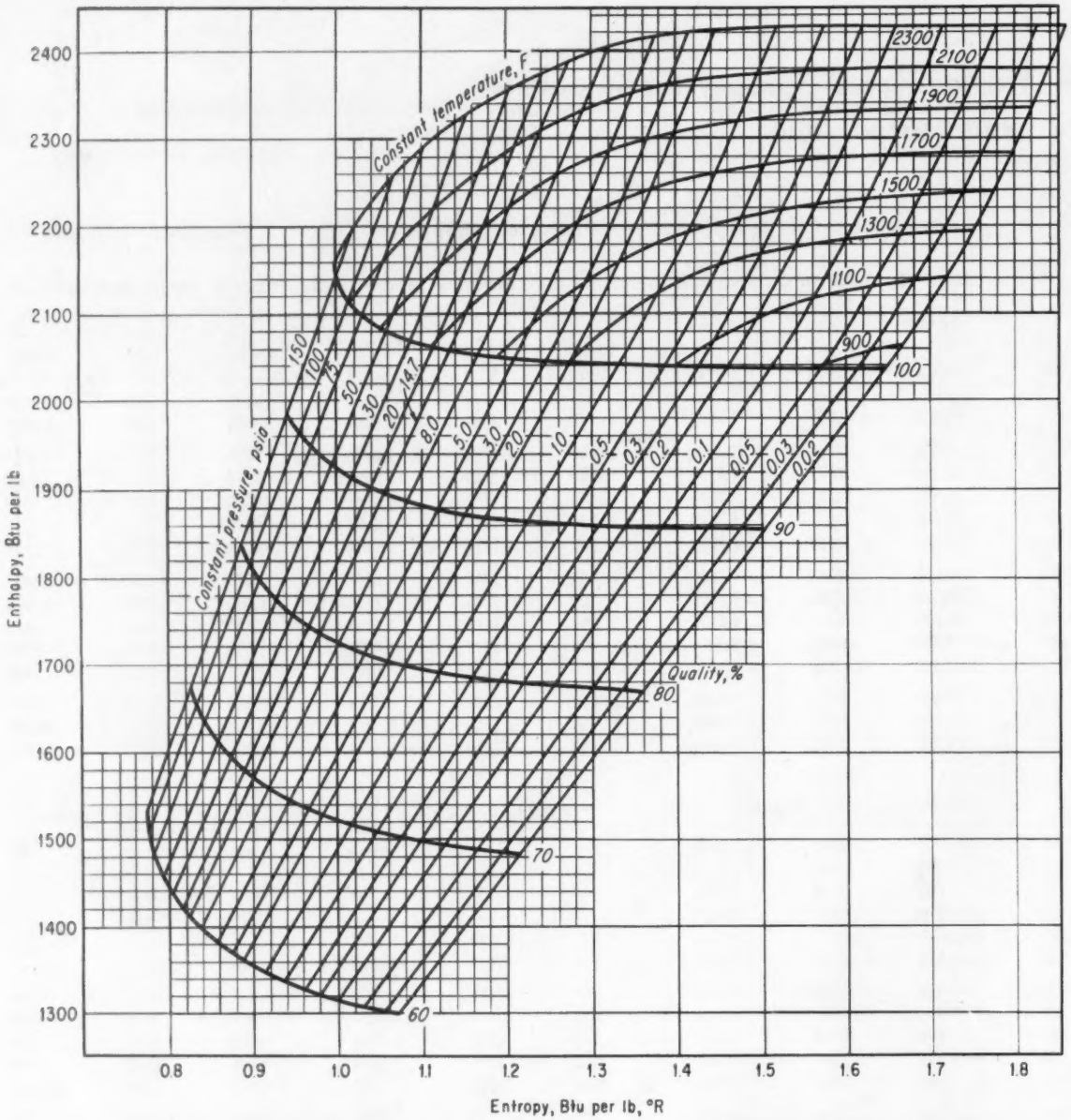
2—Thermodynamic properties of sodium, superheated vapor

Temp, F	Pressure = 0.02 psia			Pressure = 0.05 psia			Pressure = 0.10 psia		
	v, ft³ per lb	h, Btu per lb	s, Btu per lb, °R	v, ft³ per lb	h, Btu per lb	s, Btu per lb, °R	v, ft³ per lb	h, Btu per lb	s, Btu per lb, °R
821	28,530	2036	1.6453	—	—	—	—	—	—
893	—	—	—	10,560	2038	1.5697	—	—	—
900	30,830	2036	1.6733	11,910	2044	1.5728	—	—	—
954	—	—	—	—	—	—	4019	2038	1.5124
1000	33,630	2117	1.7045	13,110	2089	1.6042	4985	2063	1.5293
1100	36,060	2144	1.7223	14,300	2134	1.6356	7085	2118	1.5661
1200	38,530	2172	1.7397	15,300	2163	1.6533	7611	2152	1.5868
1300	40,950	2196	1.7536	16,300	2193	1.6711	8138	2187	1.6076
1400	43,340	2221	1.7675	17,250	2216	1.6834	8622	2212	1.6213
1500	45,680	2242	1.7784	18,200	2239	1.6958	9106	2238	1.6350
1600	48,000	2264	1.7891	19,150	2262	1.7072	9575	2260	1.6457
1700	50,330	2286	1.7998	20,100	2286	1.7186	10,040	2282	1.6564
1800	52,670	2312	1.8106	21,030	2312	1.7294	10,520	2308	1.6672
1900	55,000	2335	1.8214	21,960	2335	1.7402	11,000	2335	1.6780
2000	57,320	2358	1.8310	22,890	2358	1.7497	11,470	2358	1.6885
2100	59,660	2382	1.8405	23,820	2382	1.7593	11,930	2382	1.6871
2200	61,990	2406	1.8495	24,750	2406	1.7683	12,400	2406	1.7061
2300	64,320	2430	1.8585	25,680	2430	1.7773	12,860	2430	1.7151

	Pressure = 1.0 psia			Pressure = 5.0 psia			Pressure = 14.7 psia		
1198	702	2043	1.3309	—	—	—	—	—	—
1200	703	2044	1.3315	—	—	—	—	—	—
1300	769	2148	1.3906	—	—	—	—	—	—
1400	825	2173	1.4032	—	—	—	—	—	—
1423	—	—	—	157	2049	1.2097	—	—	—
1500	882	2198	1.4158	164	2092	1.2320	—	—	—
1600	938	2233	1.4335	177	2151	1.2606	—	—	—
1618	—	—	—	—	—	—	56.1	2060	1.1345
1700	995	2268	1.4512	191	2210	1.2892	60.2	2111	1.1285
1800	1043	2296	1.4635	202	2251	1.3075	64.8	2169	1.1893
1900	1092	2324	1.4759	214	2293	1.3259	69.4	2228	1.2102
2000	1140	2350	1.4864	224	2323	1.3382	72.9	2269	1.2269
2100	1188	2376	1.4970	234	2354	1.3506	76.5	2310	1.2436
2200	1236	2403	1.5072	245	2386	1.3626	80.9	2352	1.2596
2300	1285	2430	1.5173	255	2919	1.3745	85.4	2395	1.2756

	Pressure = 30 psia			Pressure = 75 psia			Pressure = 150 psia		
1767	29.3	2071	1.0876	—	—	—	—	—	—
1800	30.0	2092	1.0967	—	—	—	—	—	—
1900	32.2	2155	1.1242	—	—	—	—	—	—
1998	—	—	—	12.5	2099	1.0337	—	—	—
2000	34.2	2210	1.1465	12.6	2100	1.0347	—	—	—
2100	36.2	2265	1.1689	13.0	2167	1.0604	—	—	—
2200	38.4	2315	1.1877	14.1	2230	1.0841	—	—	—
2206	—	—	—	—	—	—	6.44	2139	1.0003
2250	—	—	—	—	—	—	6.70	2172	1.0142
2300	40.5	2365	1.2064	15.2	2293	1.1078	6.96	2215	1.0282

of sodium vary as shown by Mollier chart on next page



MOLLIER DIAGRAM FOR SODIUM VAPOR is based on saturated sodium liquid as datum at 208 F. Both enthalpy and entropy are assumed as zero at datum where pressure is only 0.000,000,00168 psia. Chart demonstrates high heat capacity at low pressures

Enthalpy. Melting point of sodium, 208 F, was used as the datum plane for evaluating all enthalpies. Enthalpy of the liquid was calculated as:

$$\Delta h = C_p \Delta t \qquad (7)$$

where h = enthalpy, Btu per lb
C_p = specific heat at constant pressure, Btu per lb, F
t = temperature, F

Average specific heats were used over small temperature differences. Specific-heat data is available in the literature[4] for the temperature range from 208 to 2050 F. Extrapolated values were used from 2050 to 2300 F. As a further check on liquid-enthalpy values, the following differential and algebraic equations were used:

$$dh = C_p dt$$

where $C_p = 0.389 - 1.106 \times 10^{-4}T + 0.3410 \times 10^{-7}T^2$

$$h_1 - h_2 = \int_{T_1}^{T_2} 0.389T - 0.553 \times 10^{-4}T^2 + 0.1137 \times 10^{-7}T^3 \qquad (8)$$

T is temperature, °R

Evaluation of equation (8) gives results consistent with those derived by direct methods.

Latent heat of vaporization comes from the Clapeyron equation. The values were checked by using the heats

of formation. The Clapeyron equation is:

$$\frac{dp}{dT} = \frac{h_{fg}}{T(V_g - V_f)} \quad (9)$$

where h_{fg} = latent heat of vaporization, Btu per lb
V_g = specific volume of gas, cu ft per lb
V_f = specific volume of liquid, cu ft per lb

If V_f is neglected and V_g obtained by $V_g = RT/p$, equation (9) can be written:

$$h_{fg} = \frac{dp}{dT}\ \frac{RT^2}{p} \quad (10)$$

Substituting equation (10) into equation (1) and integrating gives:

$$h_{fg} = \frac{45{,}860 - 0.993T}{M_m} \quad (11)$$

where M_m is the molecular weight of the gaseous mixture at saturation. Latent heat of vaporization can also be determined by using the heats of formation:

$$h_{fg} = \frac{X_1(\Delta H_{f1}) + X_2(\Delta H_{f2})}{M_m} \quad (12)$$

where ΔH_{f1} = heat of formation of component 1, Btu per mole
ΔH_{f2} = heat of formation of component 2, Btu per mole

Reliable values of heats of formation were found in article (5) of the bibliography.

The enthalpy of saturated vapor was found by:

$$h_g = h_f + h_{fg} \quad (13)$$

Enthalpy of superheated vapor was found by using heats of formation as follows:

$$h = h_{fg} + \frac{X_1(\Delta H_{f1}) + X_2(\Delta H_{f2})}{M_m} \quad (14)$$

Entropy. Melting point of sodium, 208 F, was used as the datum plane for evaluating all entropy quantities. The entropy of saturated liquid was figured by:

$\Delta s = \Delta h/T$

where s = entropy, Btu per lb, °R

This method was checked by evaluating:

$$s_1 - s_2 = \int_{T_2}^{T_1} C_p \frac{dT}{T} \quad (15)$$

where $C_p = 0.389 - 1.106 \times 10^{-4}T + 0.341 \times 10^{-7}T^2$

Entropy of vaporization was figured as:

$s_{fg} = h_{fg}/T$

Entropy of saturated vapor is $s_g = s_f + s_{fg}$ and entropy of superheated vapor is $\Delta s = \Delta h/T$.

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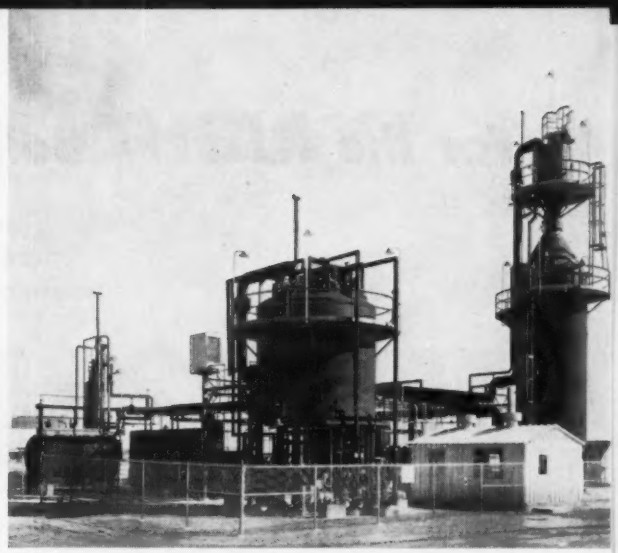


Desalt water by freezing? Pilot plant tests two methods

This plant, on Weedon Island in Tampa Bay near St. Petersburg, Fla., will try out alternate ideas for desalting water by freezing. The $500,000 project is a joint effort of the Department of the Interior's Office of Saline Waters, Blaw-Knox Company — builder of the plant, Cooper-Bessemer Corporation and the Florida Power Corporation.

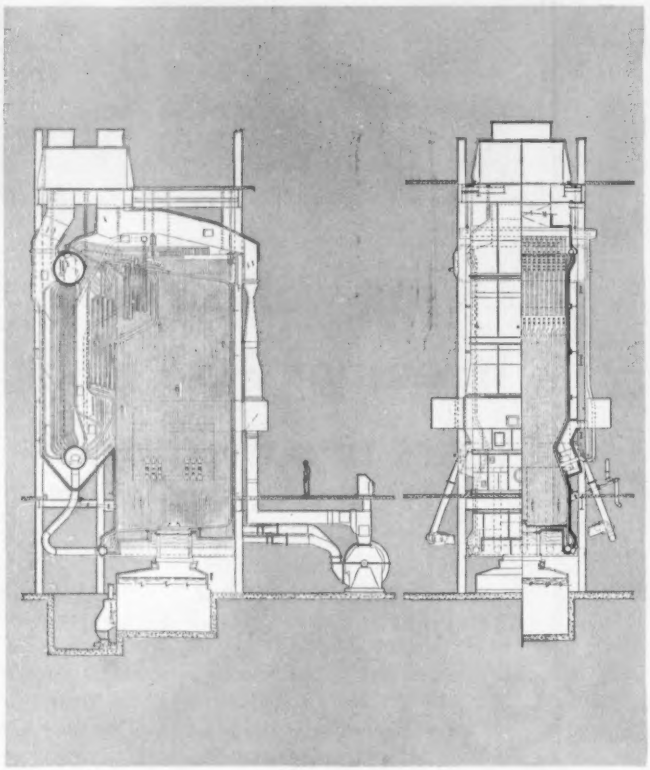
The pilot operation forms ice by vaporizing butane or isobutane in direct contact with the salt feedwater at about atmospheric pressure. The feedwater produces a shower of salt-free ice crystals. As the ice is removed from the freezer, part of the potable water washes it free of surface salt. Butane, drawn from the freezer and pressurized, melts the washed ice. The liquid butane is separated from the fresh water and recycled to the freezer.

One method, tower on right, uses the system developed by Professor H F Wiegandt of Cornell University. The other method, center tank, was developed by Blaw-Knox research laboratory. It uses the Blaw-Knox Rotocel originally built to extract oil from vegetable seed. The pilot plant is expected to yield 50 lb of fresh water from each 100 lb of sea water. There should be less than 0.05% salt in the potable water.

Estimates for this freezing method raise hopes that a 10-million-gallon-per-day plant can produce fresh water for about 50¢ per 1000 gal. Existing large desalting plants come to about $2 per 1000 gal. The pilot plant now running can produce 35,000 gpd of fresh water. A commercial plant would use an additional treatment unit to remove every trace of butane from the product water.

For the RIGHT Boiler and Firing Combination

Riley Stoker Corporation offers one of the broadest product lines in the boiler industry, particularly in cases where special boiler design and fuel burning arrangements

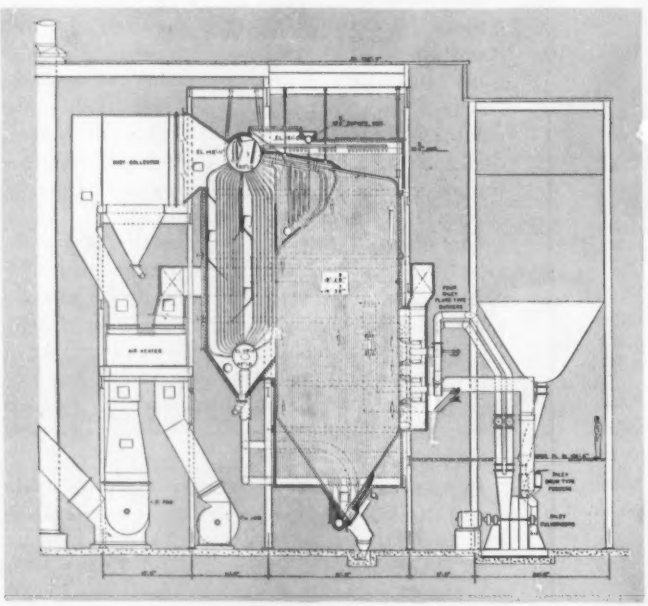


Opposed Firing In The Riley TURBO FURNACE Boiler With Riley Directional Flame Burners and Riley Pulverizers.

Electrical Equipment Manufacturer
Chicago, Illinois

Boiler Steam Capacity — 150,000 lbs/hr
Operating Pressure — 950 psig
Steam Temperature — 835 F.
Efficiency — 87.5%

The Turbo Furnace Boiler efficiently utilizes furnace waterwall surfaces providing rapid and uniform natural water and steam circulation. Uniform furnace gas distribution produces minimum variations in superheater temperatures. Almost entire absence of furnace wall deposits eliminates need for wall blowers. Carbon loss and flyash problems are kept to a minimum. The Turbo Furnace boiler can be fired by coal, oil or gas or any combination of the three and will maintain steam temperature over wide load ranges. The Turbo Furnace boiler with burners on one level arranged for opposed firing is easy to supervise and is well suited for automatic operation. This design is furnished in all capacities up to the largest central station reheat type units.



Furnace Wall Firing With Riley Flare Type Burners and Riley Pulverizers

Emery Industries, St. Bernard, Ohio

Boiler Steam Capacity — 200,000 lbs/hr
Operating Pressure — 350 psig
Steam Temperature — 550 F.
Efficiency — 87.3%

This Riley boiler design incorporates within its furnace wall circulation system the patented Riley Single Header Hopper which reduces overall height of structure and permits a higher capacity in a restricted area. By incorporating the hopper with the furnace expense of a separate hopper and its maintenance is eliminated. Riley Flare Type Burners used with this design burn coal, oil or gas separately or in combination. The design may be adapted to any steam capacity up to the largest central station reheat type unit.

For Complete Information About Riley Products Write—RILEY STOKER CORPORATION, WORCESTER, MASS.
Sales Offices: Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Detroit, Honolulu, Houston, Jacksonville, Kansas City, Los Angeles, Milwaukee, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

BUY RILEY ALL THE WAY!

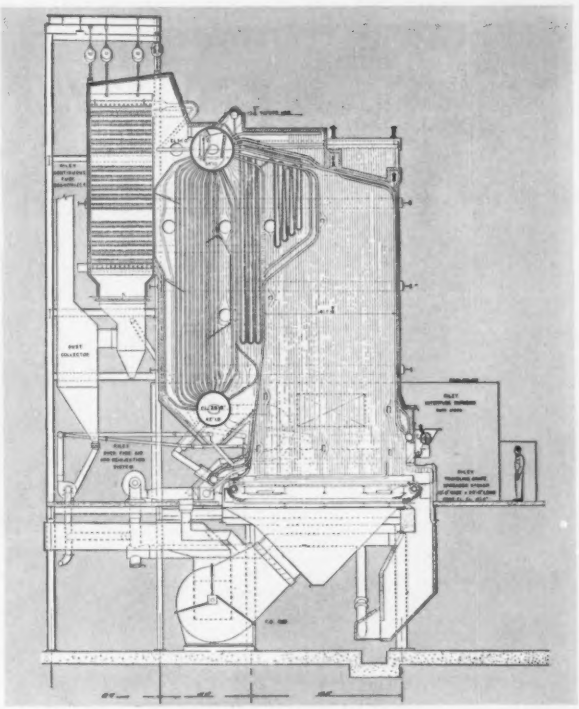
are required. When you buy a Riley Boiler complete with Riley Fuel Burning Equipment, you do so under a single contract with undivided responsibility

Spreader Stoker Firing With Riley Traveling Grate and Model "D" Feeders

Deere & Company, Moline, Illinois

Boiler Steam Capacity — 135,000 lbs/hr
Operating Pressure — 650 psig
Steam Temperature — 750 F.
Traveling Grate — 16′ x 20′
Efficiency — 87%

Unusual here is that this is the first successful application of pressure firing with a spreader stoker. The unit is also provided with Riley Intertube Gas Burners. The Riley Spreader Stoker is used extensively to burn a wide range of bituminous coals, lignite, wood refuse, bagasse and other cellulose materials. Riley Spreader Stokers are being supplied for steam capacities as high as 650,000 lbs/hr and are also available with stationary and oscillating grates.

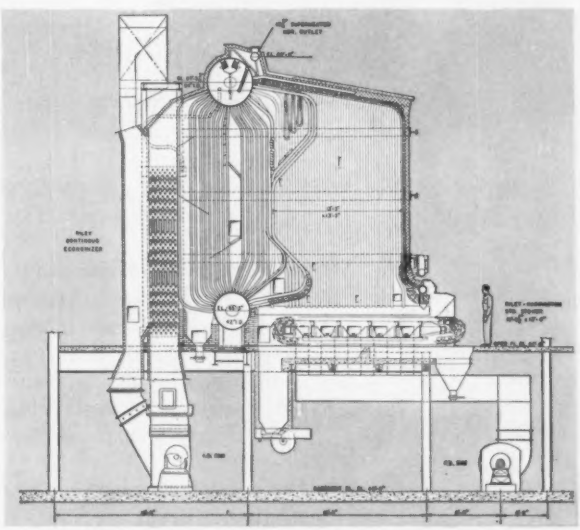


Overfeed Firing With Riley Harrington Traveling Grate

Owens-Illinois Glass Co., Bridgeton, New Jersey

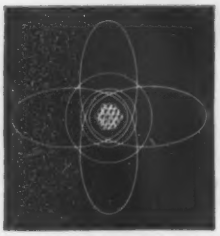
Boiler Steam Capacity — 70,000 lbs/hr
Operating Pressure — 200 psig
Steam Temperature — 460 F.
Stoker is 13′ wide by 15′ 2½″ long
Efficiency — 84.4%

The Riley-Harrington Traveling Grate Stoker efficiently utilizes fuels that have a wide range of coking, caking and ash fusion characteristics; also low grade fuels such as coke breeze, sub-bituminous and fine sizes of anthracite coals and lignite. Normally used with boilers from 50,000 to 250,000 lbs/hr capacities. Recent successful adaptions of Riley-Harrington stokers are for metallurgical coke production and incinerators.



A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

RILEY
STEAM GENERATING & FUEL BURNING EQUIPMENT



Nuclear notes

By B G A SKROTZKI, Associate Editor

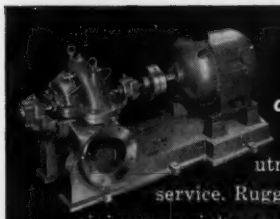
AEC reduced overall charges for uranium fuels on July 1, 1961. While base charges for the fuels dropped, the use-charge rate rose from 4 to 4¾%. The new charges correspond to a price of $8 per lb of U_3O_8 in natural uranium concentrates. Here are some examples of base charges for enriched and depleted uranium as U_3O_8:

U-235 assay in weight, %	New charges: $ per kg of contained uranium	New charges: $ per g of contained U-235	Previous charges, $ per g of contained U-235	Reduction, %
Enriched uranium				
90	12,285.00	13.65	17.07	20
20	2547.00	12.74	16.12	21
10	1195.50	11.95	15.29	22
5	535.50	10.71	13.96	23
3	281.20	9.37	12.52	25
2	160.00	8.00	11.00	27
1.5	102.60	6.84	9.70	29
1.0	49.90	4.99	7.58	34
Depleted uranium				
0.7	22.60	3.23	5.45	41
0.6	14.80	2.47	4.48	45
0.5	8.05	1.61	3.33	51
0.4	3.00	0.75	2.04	63

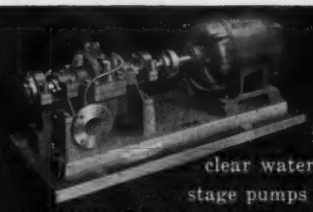
India's atomic program, under its AEC, gets into full swing with plans for a 300-mwe atomic power station at Tarapore, 65 miles northwest of Bombay. Global tenders will open on August 31, 1961. The first of two reactors is scheduled for a 1965 start. A second 20-mwe plant will be building soon, using a natural-uranium-fueled heavy-water-moderated, organically cooled reactor. (*McGraw-Hill World News*)

Second Antarctic nuclear-plant proposals have been solicited by the AEC for the U.S. Navy. First plant for McMurdo Sound will start running in 1962. The newest plant will be for the Byrd Station; designated PL-3, it will generate 1 mwe and 1.5 million Btu in steam that will melt snow to supply fresh water. Plant will be built in modules, to airlift from McMurdo Sound to the inland Byrd Station. The reactor may be a light-water-cooled and -moderated unit with either forced-circulation pressurized water or natural-circulation boiling water. Fuel: enriched uranium.

Air Force nuclear plant built by the Martin Company has been airlifted in 16 packages to the Ellsworth Air Force Base, South Dakota. From there the plant will be trucked to a radar site atop Warren Peak, seven miles from Sundance, Wyoming. The PM-1 is light-water-cooled and -moderated, fueled with highly enriched uranium to generate 1 mwe and 2 mwt for heating. According to schedule, plant goes critical in September 1961. The AEC will install and test-operate the plant for six months before handing it over to the Air Defense Command for operation. Operating crew for PM-1 includes 17 airmen and an Air Force officer plus two servicemen each from the Army and Navy. Among them, the crew has over 80 man-years of operating experience.

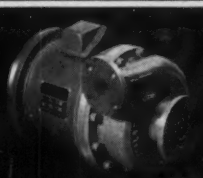


Clear Water Pumps—Double suction pumps designed for utmost efficiency in clear water service. Ruggedly built for dependability, minimum maintenance and down time. Send for Bulletin 955.



High Pressure Pumps—Ideal for boiler feed and other severe clear water service. These multi-stage pumps operate against heads to 1500 ft. Capacities to 900 gpm. For complete facts, write for Bulletin 980.

Close-Coupled Pumps—These efficient pumps save space, simplify installation. No need for shaft alignment. Vertical or horizontal models. Adjustable discharge angle. Write for Bulletin 975.

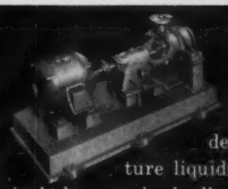


NEW! 'Buffalo' Hermetic Pumps—Quality pumps with special bearings for use where leakage would be dangerous or costly. Available in a broad range of materials of construction. Write for full details.

Non-Clogging Pumps—Move high consistency liquids dependably and efficiently. Minimize wear and wedging. Inspection simplified by diagonally split shell. Rubber-lined models for moving abrasive or corrosive liquids. Send for Bulletin 953.

Chemical Liquid Pumps—Specially designed for moving most corrosive abrasive or high consistency liquids. Your choice of many types in a variety of trim. Will withstand punishing conditions. Write for Bulletin 976.

GPL*



Heat Transfer Pumps—These special 'Buffalo' Pumps are designed to handle high temperature liquids. Job-engineered construction includes required alloys, water-cooled bearings and proper packings. Single suction, solid shell design gives peak efficiency. Write for complete details.

*** True long-range pump economy depends on GPL (Gallons Per Lifetime)...pumped day-in-and-day-out with a minimum of down-time and maintenance costs. This is the kind of long-lived reliability built into every 'Buffalo' Pump. It is the most important result of top quality design and construction.**

'Buffalo' offers a complete line of centrifugal pumps featuring parts interchangeability and low maintenance. Whatever your liquid moving needs, chances are there's a 'Buffalo' Pump to fit it perfectly. And your 'Buffalo' resident engineer is the man to recommend it. Contact him, or write us direct.

"Buffalo" PUMPS

BUFFALO PUMPS DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canada Pumps Ltd., Kitchener, Ontario

'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

For more facts circle 240 on Reader Service card, p 101

Power's data sheet

No. 347

Seamless carbon-steel pipe to ASTM Spec A-53 Grade B and Spec A-106 Grade B

Pipe size, in.	Nom OD, in.	Wall thick, in.	Temperature, F: To 650	700	750	775
			Maximum allowable stress, psi: 15,000	14,350	12,950	11,875
Schedule 10						
14	14	.250	475	455	410	376
16	16	.250	415	397	358	329
18	18	.250	369	353	318	292
20	20	.250	331	317	286	262
24	24	.250	276	264	238	218
Schedule 20						
8	8.625	.250	777	744	671	615
10	10.75	.250	621	594	536	492
12	12.75	.250	522	500	451	414
14	14	.312	594	569	513	470
16	16	.312	519	496	448	411
18	18	.312	461	441	398	365
20	20	.375	499	477	430	395
24	24	.375	415	397	358	328
Schedule 30						
8	8.625	.277	861	824	743	682
10	10.75	.307	766	733	661	606
12	12.75	.330	693	663	598	548
14	14	.375	716	685	618	567
16	16	.375	625	598	540	495
18	18	.438	649	621	561	514
20	20	.500	669	640	577	529
24	24	.562	625	598	540	495
Schedule 40						
⅛	.84	.109	1103	1055	952	873
¼	1.05	.113	997	954	861	790
⅜	1.315	.133	1200	1148	1036	950
1	1.66	.14	1078	1032	931	854
1¼	1.90	.145	1005	962	868	796
1½	2.375	.154	905	866	781	717
2	2.875	.203	1217	1164	1051	963
2½	3.50	.216	1094	1046	954	866
3	4.50	.237	1433	1371	1237	1134
4	5.563	.258	1259	1205	1087	997
5	6.625	.28	1143	1094	987	905
6	8.625	.322	1007	963	869	797
8	10.75	.365	912	872	787	722
10	12.75	.406	854	817	738	676
12	14	.438	839	803	724	664
14	16	.50	840	803	725	665
16	18	.562	838	802	724	664
18	20	.593	797	762	688	631
20	24	.687	768	735	663	608
Schedule 60						
8	8.625	.406	1277	1221	1102	1011
10	10.75	.50	1263	1209	1091	1000
12	12.75	.562	1195	1143	1031	945
14	14	.593	1148	1099	991	909
16	16	.656	1108	1060	957	877
18	18	.750	1126	1077	972	891
20	20	.812	1098	1050	948	869
24	24	.968	1091	1044	942	864
Schedule 80						
⅛	.84	.147	2434	2328	2101	1927
¼	1.05	.154	2113	2021	1824	1673
⅜	1.315	.179	2222	2125	1918	1759
1	1.66	.191	1939	1855	1674	1535
1¼	1.90	.20	1821	1742	1572	1442
1½	2.375	.218	1661	1589	1434	1315
2	2.875	.276	1942	1858	1677	1537
2½	3.50	.30	1778	1701	1535	1407
3	4.50	.337	2076	1986	1792	1643
4	5.563	.375	1856	1776	1602	1469
5	6.625	.432	1793	1715	1548	1420
6	8.625	.50	1588	1519	1371	1257
8	10.75	.593	1510	1444	1303	1195
10	12.75	.687	1472	1408	1271	1165
12	14	.75	1460		1261	1156
14	16	.843	1439	1376	1242	1139
16	18	.937	1420	1359	1226	1124
18	20	1.031	1404	1343	1212	1111
20	24	1.218	1383	1323	1194	1095

Pipe size, in.	Nom OD, in.	Wall thick, in.	Temperature, F: To 650	700	750	775
			Maximum allowable stress, psi: 15,000	14,350	12,950	11,875
Schedule 100						
8	8.625	.593	1900	1818	1640	1504
10	10.75	.718	1842	1762	1590	1458
12	12.75	.843	1823	1744	1574	1443
14	14	.937	1846	1766	1594	1461
16	16	1.031	1771	1694	1529	1402
18	18	1.156	1766	1690	1525	1398
20	20	1.281	1760	1684	1520	1394
24	24	1.531	1753	1677	1514	1388
XX						
½	.84	.294	8389	8026	7243	6641
¾	1.05	.308	6941	6640	5993	5495
1	1.315	.358	6658	6369	5748	5271
1¼	1.66	.382	5585	5343	4821	4421
1½	1.90	.400	5114	4893	4415	4049
2	2.375	.436	4480	4286	3868	3547
2½	2.875	.552	4934	4720	4260	3906
3	3.5	.600	4407	4216	3804	3489
4	4.50	.674	4394	4203	3793	3478
5	5.563	.750	3905	3736	3372	3092
6	6.625	.864	3767	3604	3252	2982
8	8.625	.875	2977	2848	2570	2357
Schedule 120						
4	4.50	.438	2740	2621	2365	2169
5	5.563	.50	2520	2411	2176	1995
6	6.625	.562	2368	2266	2045	1875
8	8.625	.718	2323	2222	2006	1839
10	10.75	.843	2182	2088	1884	1728
12	12.75	1.00	2178	2084	1881	1725
14	14	1.093	2169	2075	1873	1717
16	16	1.218	2113	2022	1824	1673
18	18	1.375	2118	2027	1829	1677
20	20	1.50	2079	1989	1795	1646
24	24	1.812	2093	2003	1807	1657
Schedule 140						
8	8.625	.812	2647	2533	2286	2096
10	10.75	1.00	2612	2499	2255	2068
12	12.75	1.125	2468	2361	2130	1953
14	14	1.25	2500	2392	2159	1979
16	16	1.438	2517	2408	2173	1993
18	18	1.562	2426	2321	2094	1920
20	20	1.75	2446	2340	2112	1937
24	24	2.062	2399	2295	2071	1899
Schedule 160						
⅛	.84	.187	3947	3776	3408	3125
¼	1.05	.218	4017	3843	3468	3180
⅜	1.315	.25	3873	3705	3344	3066
1	1.66	.25	3006	2876	2595	2380
1¼	1.90	.281	3093	2959	2671	2449
1½	2.375	.343	3237	3097	2795	2563
2	2.875	.375	2960	2831	2555	2343
2½	3.50	.438	2939	2812	2538	2327
3	4.50	.531	3379	3233	2917	2675
4	5.563	.625	3201	3062	2764	2534
5	6.625	.718	3082	2948	2661	2440
6	8.625	.906	2868	2743	2476	2270
8	10.75	1.125	2963	2835	2558	2346
10	12.75	1.312	2911	2785	2513	2304
12	14	1.406	2835	2712	2448	2244
14	16	1.593	2812	2690	2427	2226
16	18	1.781	2790	2669	2408	2208
18	20	1.968	2776	2655	2396	2197
20	24	2.343	2752	2633	2376	2178

Maximum allowable working pressure–2

Figures in table are maximum pressures, psi, for given temperatures and stresses. See June *Data Sheet 346* for basic formula used to calculate the table.

GEORGE C HALZELL, *Boston, Mass.*

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For generations extra-quality, extra-stamina Jenkins Iron Body Gates were regarded as the best buy for the money . . . even though they cost more to buy. Lower maintenance expense and extra years of service more than offset any price differential.

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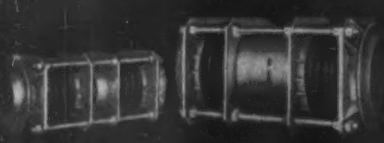
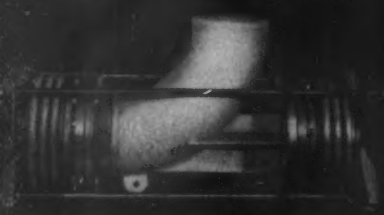
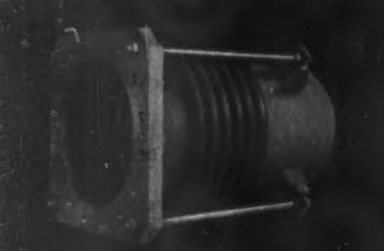


This pair of universal expansion joints is installed in the vapor piping of a gaseous diffusion plant. The lines carry Freon 114 at pressures up to 500 psig and temperatures ranging from −20°F to 300°F. Joints accommodate 3" lateral movement under these extremely harsh service conditions.



A 12" pressure balanced elbow assembly specially engineered by Badger for use in LOX storage and transfer facilities at an Air Force Missile Base. The unit is designed to operate at temperatures from −297°F to 250°F – a thermal shock range of nearly 550°! Operating pressures vary from 0 to 150 psig. Joint movement: 0.8" axial, 0.15" lateral.



One of eight specially engineered Badger Expansion Joints at a power plant for a gas recovery unit in Texas. Installation is on a cooling water piping of the surface condensers where service conditions require operation at 55 psig at a temperature of 107°F. The joints are designed to absorb ½" lateral movement in combination with ¼" axial movement.

This 24" x 44½" I.D. rectangular expansion joint, connects the turbine and condenser at a steam power plant. Each of the units is designed to operate at a pressure ranging from full vacuum to 1 psig at a temperature of 360°F. The joint handles ⅜" axial compression and a plus or minus ⅛" lateral movement.

TOUGH JOINTS

— BADGER SPECIALTY

Anyone with the necessary manufacturing facilities can fabricate expansion joints. But it takes an *experienced* manufacturer to analyze tough piping problems properly and then provide the correct expansion joints to solve them. Badger, with more than 55 years in the field, has had more experience with a wider variety of special design problems than any other expansion joint manufacturer. Put this store of skill and knowledge to work for you — get the most effective and economical solution to your expansion joint problem. Call or write for complete information about Badger S-R Expansion Joints and our "on-the-spot" engineering service.

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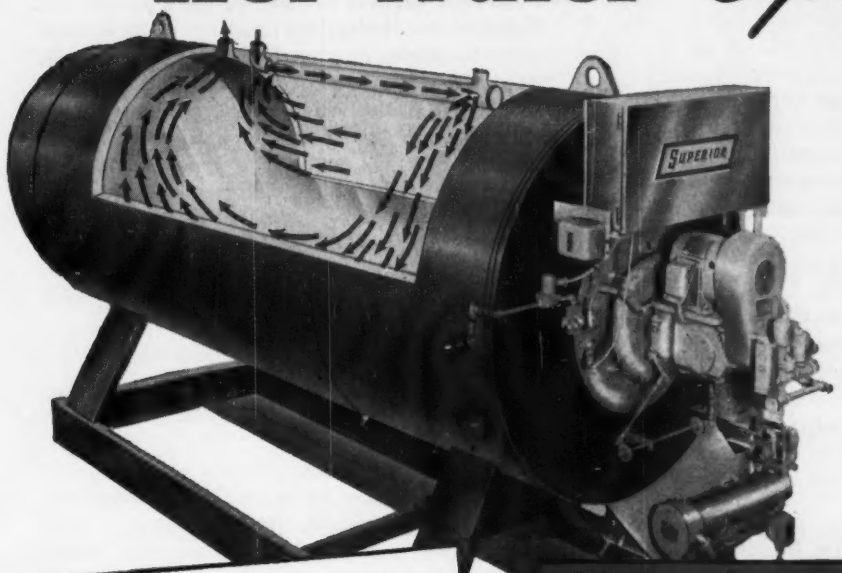

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Venturi-Action Mixing-Tube

Venturi-Action Mixing Tube
plays a triple role:

1 It starts by mixing entrained water from the boiler with water entering the boiler.

2 Traveling through the tube, temperature is further modified by the surrounding water.

3 Jet action at the end of the tube directs flow downward and outward against the outer confines of the shell, providing a circulation pattern unequalled in any other hot water boiler.

SUPERIOR "TYPE CC"

This new Superior Hot Water Boiler eliminates the problems resulting from the use of steam boilers for hot-water heating. Most of these stem from improper circulation within the boiler.

Its newly designed Venturi-Action Mixing-Tube achieves a more effective use of the natural flow pattern for maximum efficiency in hot water heating.

In addition to its special hot-water design, features include 4-pass down-draft design, 5 sq. ft. of heating surface per bhp., built-in induced draft, fully automatic operation firing gas, oil or both, and a host of other features described in detail in the new catalog illustrated at left.

For sizes to 11,720,000 Btu's/hr., write for catalog CCW-11.
For sizes to 20,100,000 Btu's/hr., write for catalog CFW-11.

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Technical briefs . . . A world-wide look at

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Lubricants and lube problems covered by two societies: ASME and ASLE

Lubricating-oil requirements of large gas engines, *L O Bowman, Calif. Research Corp; R S Ridgway, Standard Oil Company of Calif.*
In order to develop high-performance lubricating oils, preferably with low ash-forming tendencies, two sets of tests were run—one with a 2-cycle engine, one with a 4-cycle engine. Tests included: (1) paraffinic vs napthenic oils (2) effects of increasing inhibitor concentration (3) multigrade-oil use (4) comparison of detergent types (5) deposit-control performance vs oil-change interval.

One result: heavier piston-skirt and ring-belt deposition was observed with napthenic oils. Other results for both 2-cycle and 4-cycle engines are discussed and tabulated. *ASLE 61 AM 5C-3*

Molybdenum disulfide as a lubricant, *K B Wood, Climax Molybdenum Company*
History of molybdenum disulfide lube is traced from a few basic patents in the 1920's through the rapidly growing interest of recent years. Detailed comparison between hydrodynamic lubrication, wherein solids are thermally formed, and use of moly, which is itself such a solid, reveals lubrication principles. Moly's low coefficients of friction are believed to result from weak valence bonds between sulfur atoms.

Other moly topics covered: metal adherence, oxidation, stability. Commercially available formulations are listed to guide users in selection. Moly's future is assured; potential benefits in many lubrication areas are detailed. *ASME 61-MD-21*

Organizing a plant lubrication program, *H J Cohen, Northern Electric Company Ltd, Canada*
Savings provided by a planned plant-lubrication program can really mount up. But they become evident only when present practice is studied.

First step in setting up such a program is a survey of all machines and lubricants presently used. The numerous lubricants must be reduced to a minimum consistent with actual needs. Write instructions for each machine and back these up with marked photographs showing lube points.

Finally, set up a schedule flexible enough to meet plant-production needs but rigid enough to provide reliable lubrication of each piece of equipment. Your schedule must prevent building up a backlog of scheduled oil changes. *ASLE 61 AM 3C-4*

Lubrication standards. Are they really necessary? *R C Garretson, Westinghouse Electric Corp*
Bases of proposed lubrication standards at East Pittsburgh Division of Westinghouse are the JIC Standards for Hydraulics. In setting up these standards, the general rule has been to state *what* should be done without specifying *how*. This approach should standardize without being inhibitive.

Examples of proposed specifications are cited, together with the past faults which made them necessary. Vendor's lube recommendations must be specific, yet not restrictive as to make of lubricant. Several vendors' recommendation sheets are shown to illustrate what will be required. Conclusion is a firm "yes"; lubrication standards really are needed. *ASME 61 MPE-4*

Detection of damage in assembled rolling-element bearings, *Olaf Gustafsson, SKF Industries Inc*
Visual inspection of rolling-element bearings before assembly depends on human evaluation, which can easily become a variable. And many designs don't lend themselves to complete post-assembly inspection.

Test method discussed picks up vibration and records periodic or near-periodic peaks which indicate faults. Where fault is very slight, peaks may not extend beyond zone of random vibration, but these cases can be electronically detected.

Examples illustrate method. Typical vibrational velocity traces are shown. *ASLE 61 AM 3B-1*

The role of lubrication in preventive-maintenance engineering, *T R Witt, Tennessee Eastman Co*
Organization of Tennessee Eastman's preventive-maintenance program is detailed. Under this overall setup, lubrication is a specialized area directed by a Lubrication Committee.

Proper lube is a big factor in preventive maintenance. Examples highlight the value of special attention to lubrication as part of an overall program. One committee finding was that many past ball-bearing failures were due to over-lubrication. Result: some grease fittings provided with ball-bearing-equipped machinery were removed and plugged. Experience shows that, at least on some electric motors, regreasing every two to three years is not too infrequent. Detailed solutions to other lube problems complete the picture. *ASME 61 MPE-5*

Pipeline operation

Telemetering in the crude-oil and crude-oil-products pipeline industry—past, present and

future, *I B Cloessner, Humble Pipe Line Company*
Introduction of telemetering in the pipeline industry lets the dispatcher obtain data from virtually any point by the mere push of a button or turn of a dial. And more-sophisticated systems use automatic data logging. Previously the operator depended on phoned information; now he need merely observe a log sheet to obtain needed information from any pumping station or other point in the system.

A crude-pipeline system is made up of two basic components: gathering lines, trunk lines. Telemetering systems for each are covered. Among the variables involved in pipeline telemetering: tank-gage readings, gravity in deg API, pressures, flow rates, basic sediment and water content, temperatures. For example, gravity is telemetered a few miles upstream for advance warning of an approaching interface.

Choice between analog and digital telemetering in pipeline work is controversial. Increased use of solid-state electronic equipment may resolve this in favor of digital telemetering. *AIEE CP 61-16*

Operation of dual-fuel engines in pipeline service, *Erik Kelgard, Trans Mountain Oil Pipe Line Company*
Economy of operation is a prime requirement of dual-fuel engines on pipeline service. And many means are available to the operator to increase operating efficiency, including (1) thermal loading (2) valve timing (3) air-fuel mixtures.

Normally aspirated engines induct the same amount of air for each cycle regardless of load. At reduced loads this gives an excessively lean mixture, burning slowly well down on the power stroke. In the extreme, unburned gases leave the cylinder through the exhaust. But this problem has been overcome by throttling the air intake at light loads; throttling can be made automatic through sensing exhaust temperature.

To determine turbocharger speed change for best performance, a unit with externally adjustable guide vanes was used. Results: best setting was 0.7-in. open for oil, 0.01-in. open for gas.

On a continuing basis, good test results require greater use of automatic controls. But these automatic controls must be justified on bases of fuel saving and unit fuel cost. *ASME 61-OGP-1*

Energy-systems equipment

Application of centrifugal compressors to soot-blowing systems, *J W Locke and R G Thesing, Diamond Power Specialty Corporation*
Increasing central-station unit size leads naturally to centrifugal compressors to supply all station air needs. Advantages: (1) unparalleled reliability (2) minimum maintenance requirement (3) low cost of installation (4) oil-free air (5) low space requirement—and this can be vital in cramped quarters.

Operating characteristics and means of control are explained. Latter include speed control, suction and discharge throttling and variable-inlet guide-vane control. All these can apply in central stations.

During design stages, integration of soot-blowing sequence and centrifugal-compressor rating is a must. Example compares typical operating sequence applied to both reciprocating and centrifugal compressors. *APC*

Development and operation of fluid drives for turbine-generator-driven boiler-feed pumps, *R D O'Neil, American-Standard Industrial Div*
Differences between motor and turbine-generator application of fluid drives are reviewed. These include: (1) relocating accessory equipment (2) side mounting (3) increasing thrust-bearing capacity (4) using a holding brake (5) revising rotor design. But these differences are not revolutionary.

For this reason units so far in operation have shown high reliability. Currently 32 are in service or on order, designed to serve both half- and full-size boiler-feed pumps. Those now in operation are listed and detailed.

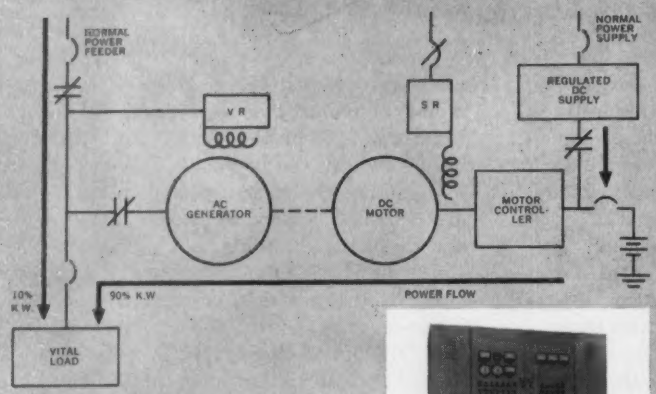
Future fluid-drive development areas: (1) meeting high hp needs, a tandem dual-rotor arrangement will have two driven and two driving members (2) developing an economically feasible smaller unit to apply where unit capability is less than 200 mw and (3) variable-speed boiler-feed-pump drive off the turbine-governor end. Latter arrangement is coming along well; one is already under construction at PG&E's Morro Bay Plant. *APC*

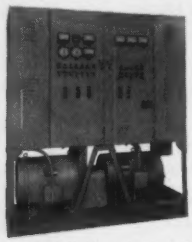
Second progress report on high-speed boiler-feed pumps, *I J Karassik and E F Wright, Worthington Corp*
Five years of field experience with high-speed boiler-feed pumps in various utility installations are reviewed (first such progress report was given at the 1957 APC). Field troubles are detailed together with corrective measures taken. Authors feel the difficulties did not stem from the basic high-speed philosophy; rather there would have been greater damage had low-speed pumps been applied. Lessons learned from field difficulties have been applied in later designs with considerable success.

Industry installation list shows areas of application for major double-case boiler-feed-pump manufacturers. *APC*

continued

AN AMMONIA PLANT APPLICATION...





In the installation pictured, the rating of the AC generator is 12 KW, .8 power factor, 1 phase, 60 cycle, 460 volt.

ANOTHER EXAMPLE OF HOW KEARFOTT ASSURES CONTINUOUS, UNVARYING POWER FOR CONTROL EQUIPMENT AND INSTRUMENTATION

The heavy losses which can occur when power interruptions or fluctuations affect the control equipment and instrumentation in manufacturing processes, are effectively prevented by Kearfott Uninterrupted Power Systems. The system described below, used in an ammonia plant, is typical of many now in use, all with a perfect record for reliability.

In this particular system, a DC motor drives an AC generator, the output of which is the same as the normal available power. Meanwhile, the DC power that runs the motor also keeps the batteries in fully charged condition. When failure of the prime power occurs, the motor continues to run on the batteries, and the AC generator continues to meet the vital power load requirement. Controls and instrumentation continue without interruption. Voltage and frequency are regulated to within ±1% of rated values, regardless of variations in normal power supply input.

Kearfott's compact uninterrupted power equipment combinations are also available in 2 and 3 unit systems operating in parallel with or isolated from the line. Provisions may be had for audible and/or visual alarms to indicate over- and under-voltage, overload or ground conditions.

Generator ratings to 150 KVA 60 and 400 cycles, single and polyphase. Frequency, voltage and transfer regulations as required by the application.

Write for complete data

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Little Falls, New Jersey

Technical briefs

Begins on page 90

Standards

American Standard specification for rigid aluminum conduit, *American Standards Association*
This new standard, designated C80.5-1960, covers specifications for conduit couplings, elbows, bends and nipples. Included also are test procedures and inspection. *ASA*

Pipe friction manual, *The Hydraulic Institute*
Replacing earlier tentative standards, this new pipe-friction manual is based on extensive experimental data. It includes complete data on friction losses in common piping from ⅛- to 84-in. ID, together with comparable data on valves and fittings.

Numerous examples show actual mathematical solutions to pipe-friction problems. Included in addition are friction-loss moduli, friction-factor charts, roughness-factor charts and viscosity tables. *HI*

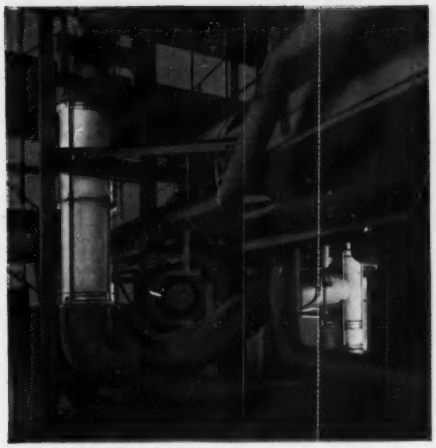
Gas turbines

Materials keep pace with industrial gas-turbine needs, *H B Gayley, Westinghouse Electric Corp*
Material-testing procedures for both turbine-disk and -blade alloys show time vs operating-temperature characteristics. Then tests of actual turbine parts after long operating periods confirm application limits. These test comparisons permit scheduled replacement of parts nearing end of service life.

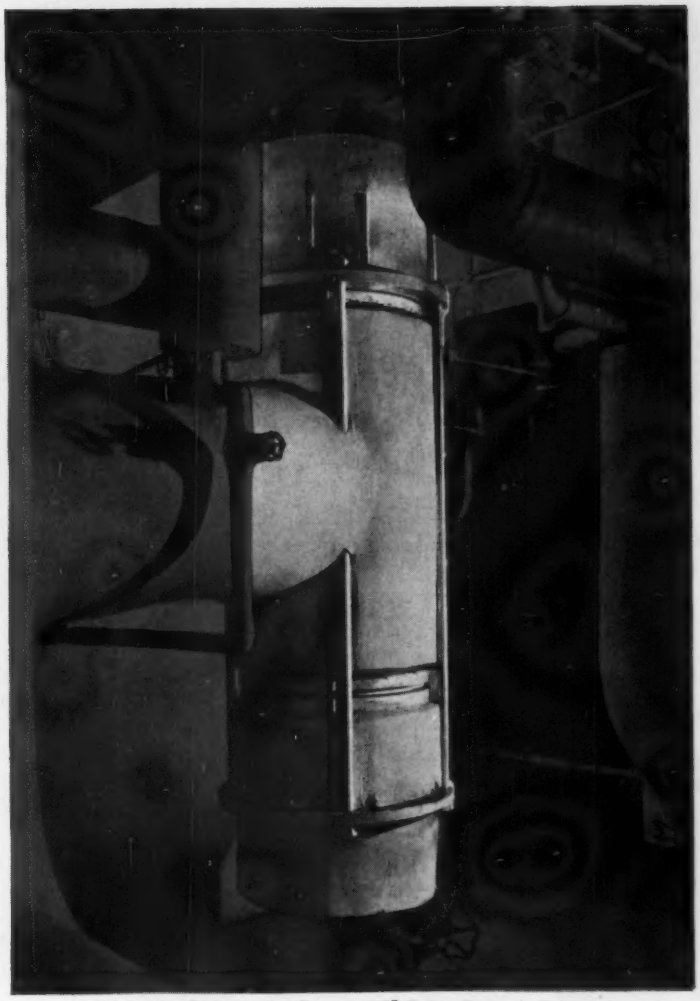
Another result of test analysis: materials now available, when fully evaluated, will permit metal temperatures topping today's high by 100 F. *ASME 61-GTP-15*

The Orlando gas turbines, *C H Stanton and H C Luff, Orlando Utilities Comm, Orlando, Fla.*
Severe peaking problems in 1958 prompted the Orlando Utilities Commission to buy two 16.5-kw gas turbines to augment their basic steam-electric system. Installed cost was $3-million less than like steam capacity; operating savings were estimated at $140,000 a year. Installation is completely described.

Operating experience has come up to expectations. 20-min startup from



In the foreground, a 20" ZALLEA Universal Expansion Joint absorbing lateral movement.



At a major Eastern oil refinery, a 20" Zallea Pressure Balanced Expansion Joint installed on a steam turbine exhaust nozzle.

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Six tough Zallea Expansion Joints protect three 10,000 kw turbine generators from the wallop of thermal stresses . . . real hot-spot duty. Each generating unit has a 20" pressure balanced, self equalizing expansion joint installed at the turbine exhaust nozzle to absorb reaction load due to internal pressure acting against the turbine casing. A 20" universal expansion joint absorbs lateral deflection in the pipe run from the pressure balanced unit. Temperatures range from 0° to 615° at start-up, back to 475° in operation, at 200 psig. To cope with these cycles, the turbines demand—and get—the maximum reliability of Zallea Expansion Joints.

Whatever the service, none of the many factors affecting Zallea Expansion Joint reliability are left to guesswork. Zallea Expansion Joints are hydraulically formed. Advanced welding techniques insure welds having the same thickness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers you more application engineering experience. These are just a few of the reasons Zallea Expansion Joints can and do outlive the equipment they serve. Sooner or later, ordinary expansion joints hand you a bill for unscheduled downtime, lost output.

Got a tough one coming up? Call in an experienced Zallea design and application specialist. Knows every inch of his product, can assist with every facet of your problem. And write for catalog 56, Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

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Technical briefs

Begins on page 90

cold to on-the-line is common. After 1500-hr operating time on each unit, necessary maintenance stayed within bounds. Visual boroscope inspection of combustion liners at 100-hr intervals kept track of cracking troubles. After about 1300 hr, cracking had progressed to the point where replacements were needed. Continued inspection—perhaps at longer intervals—will monitor this condition. *ASME 61-GTP-6*

Water technology

Boiler-scale prevention with EDTA chelating agents, *J C Edwards and E A Rozas, Dow Chemical Company*

Tests with a 10,000-lb-per-hr 150-psig boiler which had a bad scaling history established efficiency of a chelating agent for scale removal. Boiler was first cleaned with the chelating agent, although normally this part of the test could not be justified economically. Then several runs with intermittent injection kept the boiler clean.

Based on 100% makeup, initial treatment was calculated at 10.9-lb (or 1-gal) chelating agent per day. Ten lb of this solution will prevent precipitation of 1-lb $CaCO_3$ or its equivalent. Final treatment increased chelating-agent injection to about 33 lb per day.

Economic evaluation shows advantage of chelating agent over annual acid cleaning. *APC*

Prevention of corrosion in steam systems under changing load conditions, *M Stein, Illinois Institute of Technology*

Surge-tank and deaerator corrosion increases greatly when power units are relegated to intermittent duty. Then air gets into the cycle, promoting deterioration. And under light loads, deaeration effectiveness decreases and venting drops off.

Inert-gas blanketing of deaerators can preclude air entrance, cutting corrosion possibilities at no-load. Proposed fully automatic method of gas control indirectly senses corrosive situations. On startup, inert gas is purged. System not only protects the deaerator itself but also associated equipment—valves, pumps, piping.

continued

51 SOLUTIONS TO PIPE MOTION PROBLEMS

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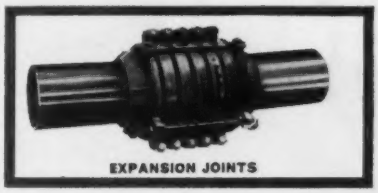
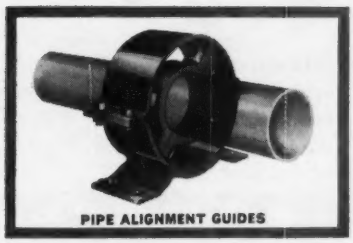
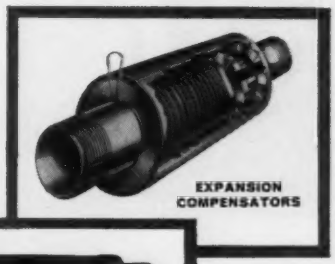

EXPANSION JOINTS


PIPE ALIGNMENT GUIDES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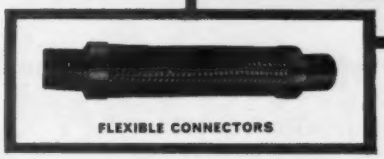
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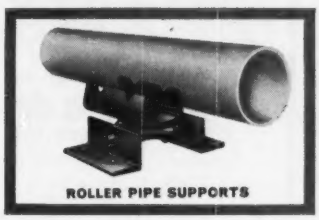
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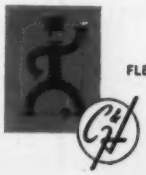

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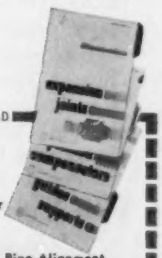

For more facts circle 247 on Reader Service card, p 101

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Technical briefs

Begins on page 90

Other corrosion-prevention hints include valve arrangement. *APC*

Operating experience with high-flow-rate condensate-polishing equipment at Dresden, *A B Sisson, Commonwealth Edison Co; R C Reid, General Electric Co; H W Frazer, Infilco Inc*

Condensate-polishing equipment at Dresden includes three externally regenerated mixed-bed demineralizers operated at a rate of 50 gpm per sq ft. Two demineralizers handle full condensate flow; one is standby. No prefiltration equipment is provided. Design requirements of polishing equipment are reviewed.

Results of initial startup and 60% power run are given. Operating difficulties involved other equipment, but had secondary effects on the demineralizers themselves. Means taken to correct these problems are listed.

Resin-transfer experience and regeneration is discussed, stressing low resin loss. *APC*

Mixed-bed demineralizers in series for optimum operating control, *E Schmidt, L.A. Water Conditioning, Inc and N W Sager, City of Burbank, Calif.*

Preliminary evaluation and operating experience show benefits of two mixed-bed demineralizers in series. In normal operation, second bed in the series is most recently regenerated. Then first bed can be run to breakthrough because any silica leakage is caught by the second bed.

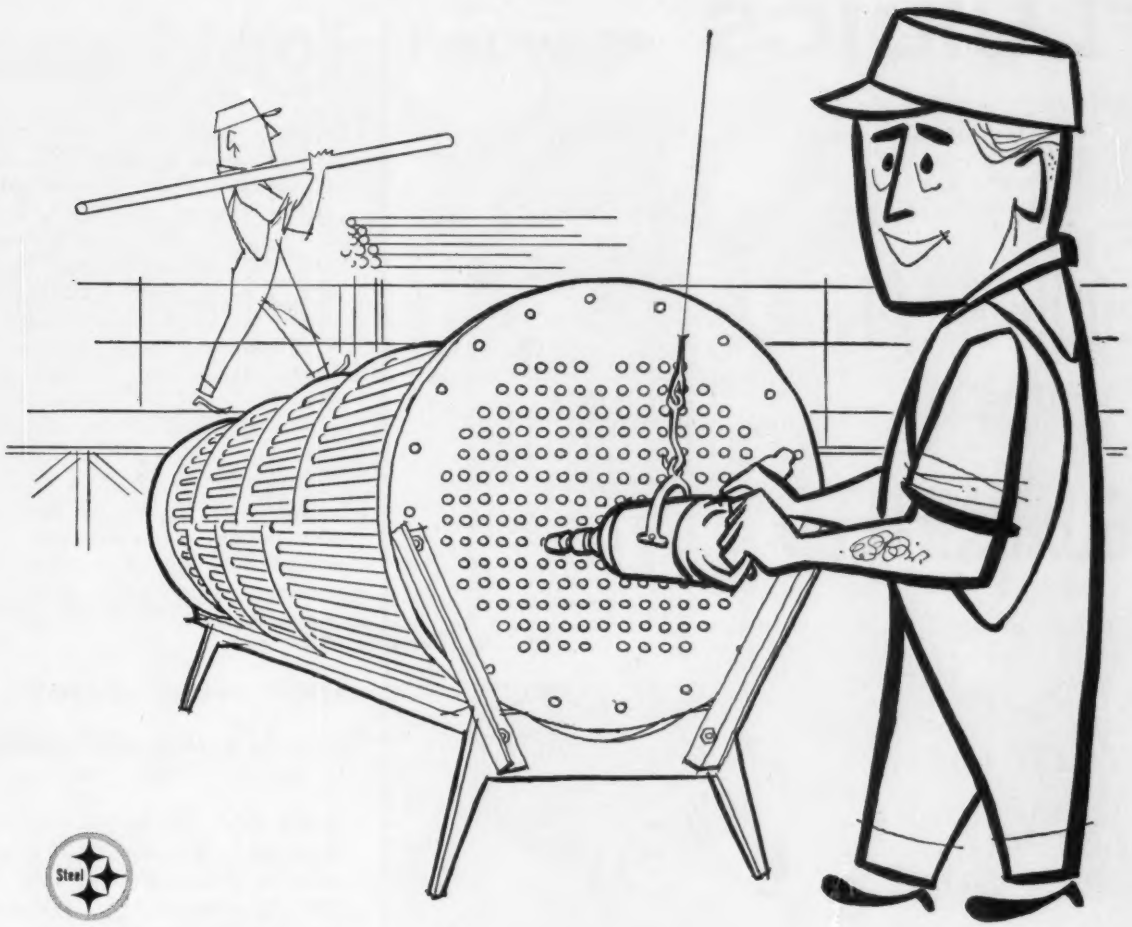
Scheme is particularly attractive for low-alkalinity waters where value of intermediate CO_2 removal is relatively small. It is also advantageous for small systems where greater complexity cannot be justified and minimum operating attention is essential.

One disadvantage to mixed-bed demineralizers in series is higher chemical cost for regeneration. In some cases, all the alkalinity and CO_2 in the raw water must be removed by ion exchange which requires the use of more caustic soda. *APC*

Some practical solutions to industrial water-treatment problems, *R S Walters, United States Steel Corporation*

Steel-mill steam systems are complex.

continued



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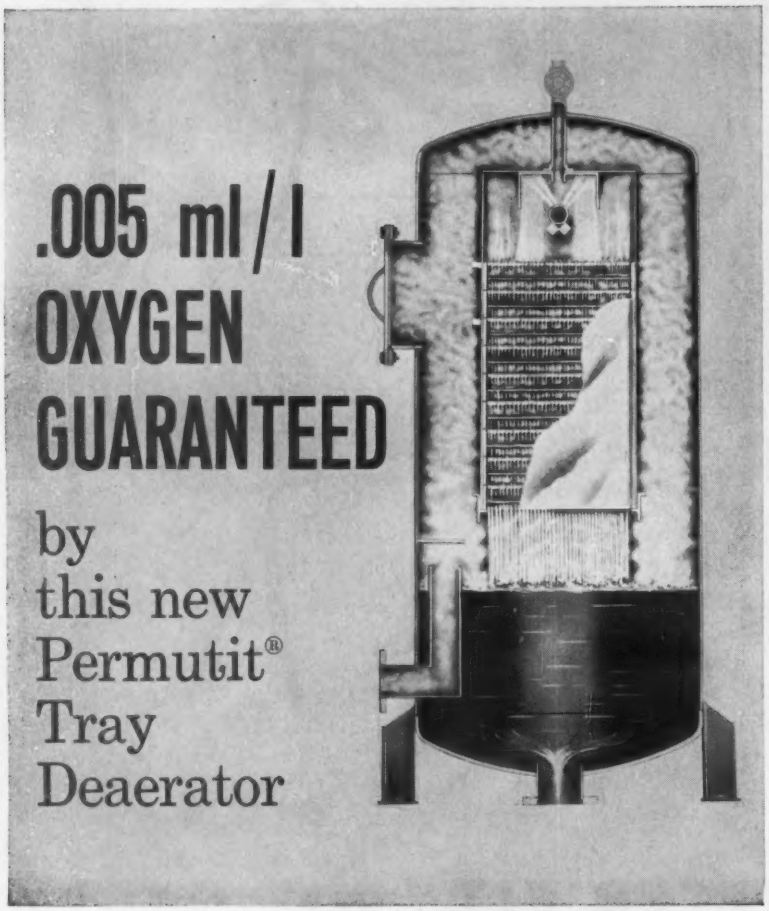

The picture above illustrates the new Permutit Tray Deaerator, which is *guaranteed* to reduce oxygen to .005 ml/l, or less, and to remove all the free CO_2.

This sectioned illustration shows the stainless steel trays and inner chamber. Steam passes upward through them, while the water spills down from tier to tier, constantly being exposed to the steam until, fully deaerated, it reaches the reservoir at the bottom.

The highest temperature incoming steam contacts this final deaerated water. It is also the purest, oxygen-free steam, and as it sweeps upward it takes to the vent all the freed corrosive gases.

The highly efficient internal vent condenser saves B.T.U.'s by reducing vented steam to a negligible wisp which is just enough to carry off all the non-condensable gases.

Guaranteed Water

These and the other design aspects of the Permutit Tray Deaerator enable us to give you a *guarantee* that you'll always get feedwater with (a) less than .005 ml of oxygen per liter of water, and (b) no titratable free CO_2.

And just off the presses is our Bulletin 4732, containing information on the construction details, operation, and other advantages of the Permutit Tray Deaerator. Send for a copy.

Permutit Division, Dept. PO-71, 50 West 44th Street, New York 36, N. Y. In Canada, The Permutit Company of Canada, Ltd., 207 Queen's Quay West, Toronto 1, Ontario.

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Technical briefs

Begins on page 90

In this case they involved three separate generation pressures, 450, 250 and 850 psig. Problems to be overcome included excessive reaming of boiler tubes to remove scale deposits.

In the 450-psig system, 20% makeup led to high boiler-cleaning costs. Solution: modernizing softener —to downcomer-sludge-contact type —and revamping filters to increase effective use of filter media. Latter step involved changing peripheral underdrain system to a modified-porous-plate design.

Problems and solutions with the other pressure steam generators are detailed with special emphasis on benefits of modernization vs replacement at higher cost. *APC*

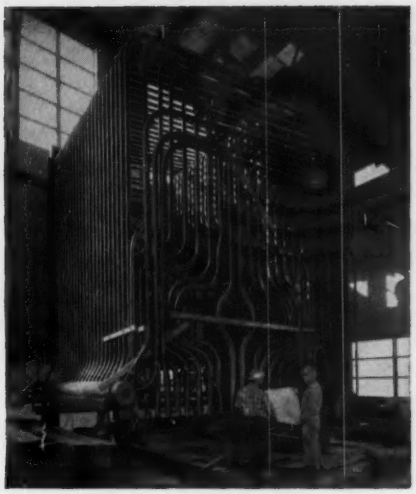
Other energy systems

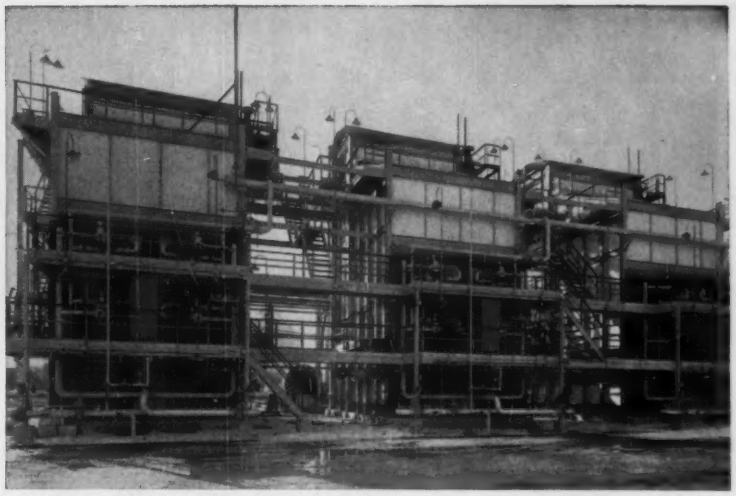
Progress in electrical generation in Canada—1960, *(Bulletin No. 2720)*
During 1960, a net total of 1,741,820 hp of new hydroelectric capacity was added in Canada after allowing for 4680 hp dismantled or destroyed. Total installed capacity of new water-power plants in Canada is now listed at 26,372,444 hp. In 1961, additional capacity to be added is limited to about 243,000 hp, but construction is proceeding on a total of 4,500,000 hp with provision for an additional million hp in later years. *WRB*

Status report on thermoelectricity by Dr J W Davisson and J Pasternak, U.S. Naval Research Laboratory (*PB-161-977*), Aug 1960, 64 pp, $1.75. *OTS*

Thermoelectricity abstracts, U.S. Naval Research Laboratory, (*PB-161-714*), Aug 1960, 94 pp, $2.25 *OTS*

Individual pumps for reliable lubrication, *S E Leese, Houdaille Industries, Inc*
In presenting the case for individual lubricators at each point of delivery, author cites many advantages: (1) Each lubricator is independent of any other part of the system. (2) Pressure generated is just sufficient for the one particular point. (3) Drive can be tied to machine motion and made





AT LEFT: Installing a 60,000 lbs/hr unit in a brewery

ABOVE: A battery of 125,000 lbs/hr units in a chemical plant

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Vogt engineering advances can save you money if you have a steam generating problem. Custom-built installations shown, are engineered to assure efficient, dependable steam generation for power, process and heating. Our engineering staff is available to give effective help in the solution of steam generating problems peculiar to a wide variety of operating conditions. Address Dept. 24-BP.

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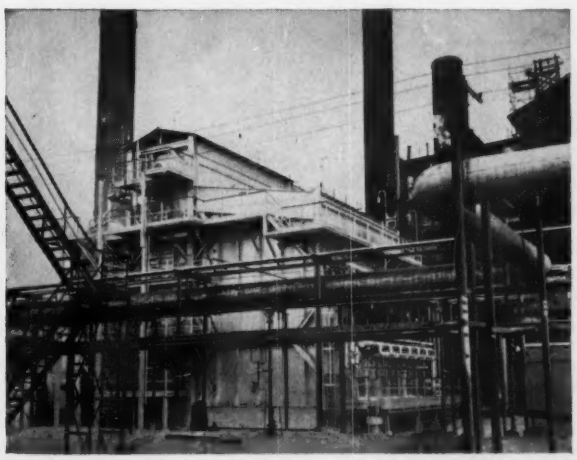
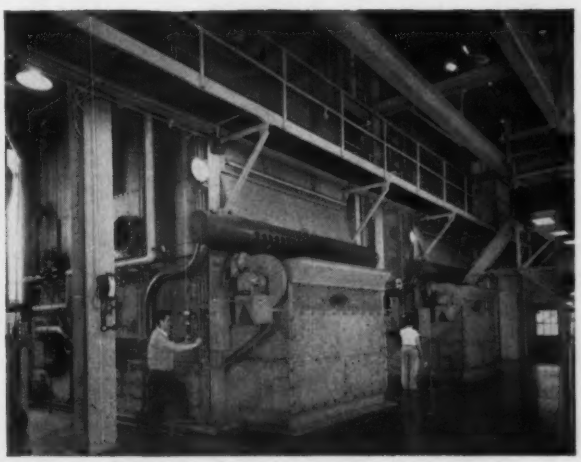


This 400,000 lbs/hr unit is installed in a leading petroleum refinery



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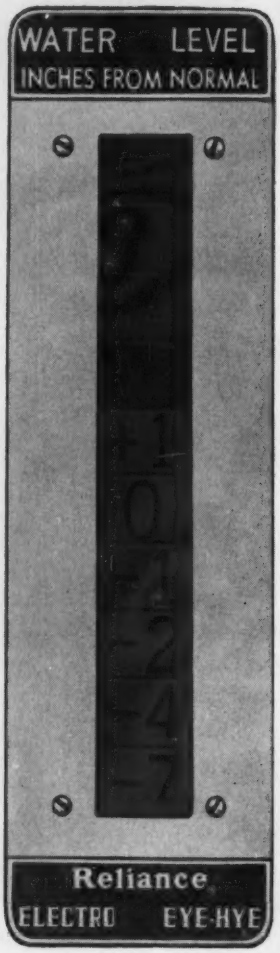
6. Up to 3,000 p.s.i. Steam Service!



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Technical briefs

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to coincide. (4) Plugging can only adversely affect one point.

In all cases, "lubricator" includes pump, drive and reservoir. Three basic pump configurations, one twin-plunger and two single-plunger types, are described.

Other topics: techniques for measuring volume pumped; accuracy of vacuum sight pumps vs drop counting. *ASLE 61AM 2A-2*

Correction

In June 1961 *Technical Briefs*, p 113, we reviewed a paper by M E Gilwood and J G Mack entitled *Considerations regarding demineralization and flash evaporation of high-pressure boiler makeup water*. The economic comparisons in the review were reversed. In both cases, the cost advantage of the demineralizer occurs at *less*, not *more*, than stated electrolite content.

To obtain complete text

Material for these abstracts comes from the following sources. Order complete paper from source, *not* POWER.

ASME: American Society of Mechanical Engineers, 29 W 39th St, New York 18, N.Y. Members, 50¢; nonmembers, $1.00.

ASLE: American Society of Lubrication Engineers, 5 N Wabash Ave, Chicago 2, Ill. Members, 50¢; nonmembers, 75¢.

APC: American Power Conference, Illinois Institute of Technology, Technology Center, Chicago 16, Ill. Papers will be published as a book—price $8.00.

ASA: American Standards Association, 10 E 40th St, New York 16, N.Y. 50¢.

HI: The Hydraulic Institute, 122 E 42nd St, New York 17, N.Y. $2.00 domestic; $2.40 foreign.

AIEE: American Institute of Electrical Engineers, 33 W 39th St, New York 18, N. Y. Members, 50¢; nonmembers, $1.00.

WRB: Director, Water Resources Branch, Dept of Northern Affairs and National Resources, Ottawa, Canada. No charge.

OTS: Office of Technical Services, U. S. Dept of Commerce, Washington 25, D. C. Prices as shown.

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New free literature

General equipment and key materials for systems engineering

• Instrumentation

101 **Rectangular lamps** are multiple-indicating for panelboard and electronic use in 6- to 120-v range—shown in 4-p folder. The H R Kirkland Co

102 **Rectilinear recorders** feature 2 to 6 channels—topic of fact sheet SM 200-002 from Curtiss Wright Corporation

103 **Indicating gages** are topic of 32-p catalog DH-54. Illustrates construction features, operation, calibration and adjustment of pressure, vacuum and compound gages. Helicoid Gage Div, American Chain & Cable Company, Inc

104 **Discharge-gage** and 2-station thermocouple-gage control is subject of data sheet. Combination permits vacuum-system monitoring with one control. Vacuum-Electronics Corp

105 **Gages** feature integrally cast solid wall for explosion protection. Details are given in bulletin from J E Lonergan Co

106 **Limit switch** is described in data sheet 185. Indicating lamp tells whether circuit is being controlled. Micro Switch Div, Minneapolis - Honeywell Regulator Company

107 **Pneumatic temperature transmitter** is described in 8-p specification S 630-1. It uses a filled thermal system. Industrial Div, Minneapolis-Honeywell Regulator Company

108 **Translator** for programed and remote positioning and indexing and indicating is illustrated in 4-p folder SS361. The Superior Electric Company

109 **Transistorized vibration meter** is portable, self-contained. Featured in 4-p circular PR-9252, meter shows absolute and relative amplitudes directly on dial. The Korfund Company, Inc

110 **Pneumatic multiplying relay** for temperature and pressure compensation and remote ratio setting is feature of spec sheet 451.23. Republic Flow Meters Company

111 **Portable potentiometer indicator** is discussed in revised 4-p brochure 64-1. Highlights specifications, applications and accessories. Thermo Electric Co, Inc

112 **Electrolytic-conductivity meters** are diagramed in 4-p folder E-95(3). Shows unit operation and connection to a typical control system. Leeds & Northrup Company

113 **Plug-in limit switch** operates four circuits with each lever direction. Spec sheet 187 gives details. Micro Switch Div, Minneapolis - Honeywell Regulator Company

114 **Ac and dc tachometer generators** and indicators are topics of 12-p bulletin GEZ-3251. Written for original equipment manufacturers, bulletin shows applications, calibrations and selection method. General Electric Company

115 **Solid-state multiplexing system** expands to cable and wire-line

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operation on carrier frequency basis—described in data sheet from Lynch Communication Systems Inc

116 **Programing aid** means the programer need not speak his machine's language like a native. Brochure describes automatic system for use with manufacturer's equipment. Minneapolis-Honeywell Regulator Co, Electronic Data Processing Div

117 **One add-a-tester** plugs into manufacturer's adapter to make a dc ammeter, other milliohmmeter measures as low as .001 ohm. Fact sheet is available from Simpson Electric Company

118 **"Temperature recording** from platinum resistance sensors" is title of 12-p booklet. Combination amplifier-sensor records −320 to +2000 F. Brush Instruments Div, Clevite Corp

- **Piping, valves, fittings and specialties**

119 **Introduction** to new manufacturer of pipe, pipe fittings, sheet in PVC, polyethylene and ABS fabrications is given in 8-p catalog. Trans-Plastics Corporation

120 **Hermetically sealed valves** for pressurized-water reactor, containment of radioactive or highly corrosive liquids and gases are topics of 8-p brochure. Atomic Power Dept, United Shoe Machinery Corp

121 **Four-way valve** is diaphragm-operated. It hydraulically actuates cylinder operators mounted on valves or controllers. 8-p spec sheet shows installation. B-I-F Industries

122 **Manually** and pneumatically operated ball valves are diagramed in 32-p catalog. For temperatures from −150 to +600 F, pressures to 1000 psig, valves are top-entry for repair without line removal and 1-piece bar-stock-body units. Hills-McCanna Company

123 **Liquid-level-gage valves** are union and screwed bonnet for leakproof service. 4-p folders 397 and 398 include drawings and tables of features. Jerguson Gage & Valve Co

124 **Pressure - temperature ratings** chart 593 for materials used in steel valves includes 300- to 2500-lb ASA pressure classes. Edward Valves, Inc

125 **High-pressure valve** is subject of data sheet 103. Split-body bar-stock control valve is built to 2500-lb ASA rating, 6000-psig cold-working pressure. Conoflow Corporation

126 **Semisteel valves** and accessories are illustrated in revised 44-p bulletin V-203. Details straightway, steam-jacketed and multiport valves. Rockwell Manufacturing Company, Nordstrom Valve Div

127 **Cast-steel lubricated plug valves** use ball-bearing system to handle high-pressure line thrust. 16-p booklet features size and rating tables. Walworth Company

128 **Determining flow** characteristics of manufacturer's valves is covered in revised 20-p bulletin V-602. Pressure drops for plug and venturi valves are charted. Rockwell Manufacturing Company, Nordstrom Valve Div

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NEW FREE LITERATURE continued ..... circle key numbers, page 101, for your copies

129 **Questions and answers** about valves and their operation in reciprocating compressors is the topic of 44-p booklet. Chapter traces valving history. Ingersoll-Rand Company

130 **Teflon high-pressure hose** in a −16 size is rated at 3000 psi for −65 to +400 F. 8-p brochure is available from Resistoflex Corporation

131 **Magnetic trap** can be installed in 2-, 3- or 4-in. pipeline. Data sheet 1910D-N gives details. Dings Magnetic Separator Company

132 **Unions** and union fittings are cataloged in 16 pp on design, weights and dimensions. Stockham Valves & Fittings Company

133 **Venturi accessories** are topic of 4-p pamphlet. Covers straightening vanes, vent cleaners and flushing devices. B-I-F Industries

134 **Threaded inserts and studs** are subject of revised 28-p catalog D. Describes 1-piece floating miniature, solid and hydraulic inserts with and without internal thread lock. Newton Insert Company

135 **Urethane hydraulic seals** and packings catalog features elastomer's chamfered sealing-lip design. Installation and procedures are described in 8 pp. Disogrin Industries Div, Pellon Corp

• Materials

136 **Silicone-rubber** selector guide is chapter of 8-p brochure CDS-129C. Categories covered include silicone fluids, protective coatings and electrical insulation. General Electric Company

137 **Synthetic-rubber compounds** and protective coatings are described in 16-p catalog. Gives applications of resins, primers and epoxies. David E Long Corp

138 **Heat-resistant laminate** can be used at 1000 F for a short time and up to 500 F in continuous service. Data sheet gives property values. Synthane Corporation

• Prime movers

139 **Gas, dualfuel and diesel engines** and pipeline pumping are some topics in 24-p product catalog available from Nordberg Mfg Co

140 **2-cycle gas engines** handle variable speeds and loads. Constant-pressure turbocharging and ignition-timing control are discussed in 4-p folder 205. Clark Bros Co

• Heat exchangers

141 **Counterflow block heat exchanger** is subject of 8-p booklet S-6813. Five flow arrangements use one, three and five passes. National Carbon Company

142 **Heat-exchanger** data sheet 451 illustrates removable - bundle units with floating-clamp-ring design. American-Standard Industrial Div

• Welding

143 **Preheating** and stress-relieving problems are discussed in 32-p booklet EW-249. Post-heat treatments for welded joints and repairing thermocouples are chapters. Hobart Brothers Company

144 **Hardfacing electrodes** and wires are topic of 44-p brochure. Type

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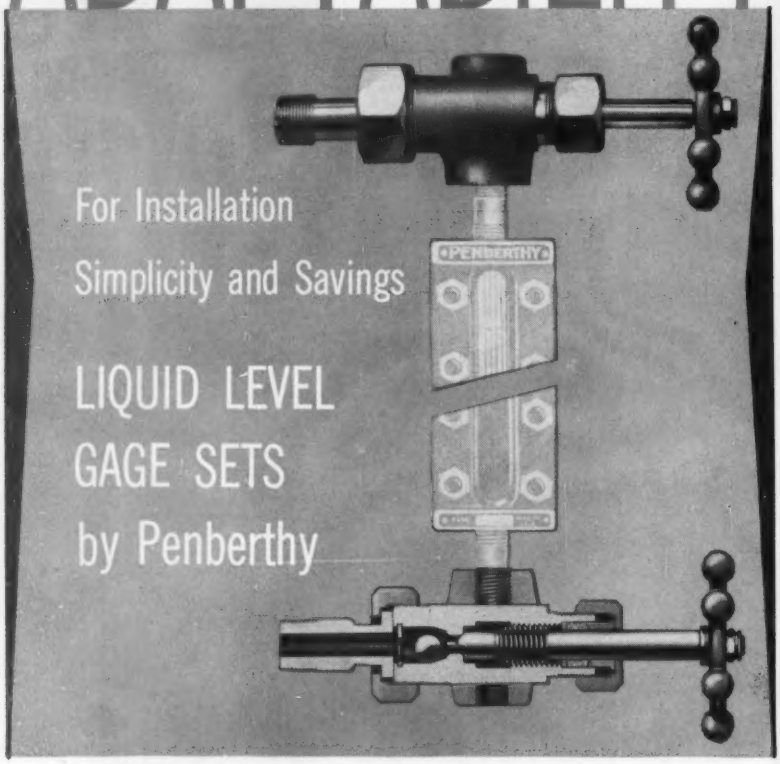
For more facts circle 253 on Reader Service card, p 101

ADAPTABILITY



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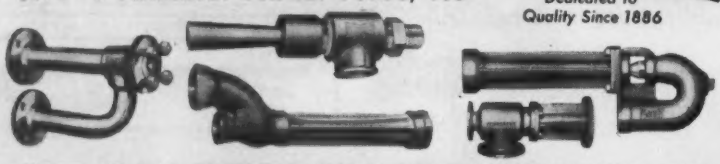

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For more facts circle 254 on Reader Service card, p 101

Free literature

Begins on page 101A

of wear on each equipment part is listed with alloy needed to protect it. Air Reduction Sales Company

- **Lubrication**

145 **Sticks of solid lube** in resin binder are used on grinding wheels and cutting tools. See circular 128 from The Alpha-Molykote Corporation

146 **"Lubricating oils** for industrial and heavy-duty automotive engines" is title of 75-p booklet. Commercial oils and company names are listed. Price: 35¢. Internal Combustion Engine Institute

Air-conditioning systems

147 **Fans** for ventilating and exhaust systems also handle temperatures to 2000 F and serve with pneumatic conveying systems. 6-p pamphlet is available from Garden City Fan & Blower Co

148 **Centrifugal all-epoxy filter** systems specifications are given in data sheet 802. Capacities: from 300 to 2700 gph. Sethco Manufacturing Corporation

Electrical systems

149 **Dc power-supply** 24-p handbook shows how to figure packaging dimensions for multiple dc outputs. Dressen-Barnes Electronics Corporation

150 **Insulation testers,** 500 and 1000 v, are hand-, rectifier- and dual-operated. 14-p bulletin 21-45-23 gives details. James G Biddle Co

151 **Flexible laminates** for temperature classes A and B are described in 8-p brochure. Varnished-cambric and polyester-film laminations with other materials are listed. Irvington Div, Minnesota Mining and Manufacturing Company

152 **H-v dielectric-testing** equipment is topic of 12-p publication GEA-7178. It pictures capacitance bridges, impulse generators and h-v sphere gaps. General Electric Company

153 **Pocket dynamometer** measures torque and power loading of small electric motors. Literature is available from Micro Pump Corporation

- **Generation, transformation and conversion**

154 **Synchronous ac generators** are rated 187 kva and larger. These nonpackaged units are topic of fact sheet 2100-PRD-254. Electric Machinery Mfg Company

155 **Dry type transformers,** ¼ to 10,000 kva, are topic of 8-p bulletin 611. Gives application, insulation,

K&M SPRAYED "LIMPET" ASBESTOS® thermal insulation provides you with a tidy savings of 35% on labor costs for installation.

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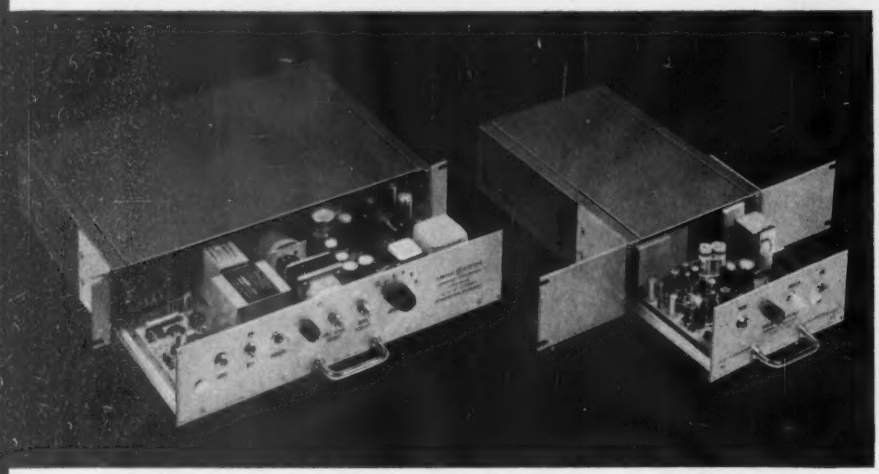
NEW GENERAL ELECTRIC

Transistorized Analog

FREQUENCY TELEMETERING OFFERS GREATER SPEED OF RESPONSE, INCREASED ACCURACY



Now available! General Electric's all-new Analog Frequency Telemetering System provides greatest possible *FLEXIBILITY* to meet utility load dispatching and industrial data transmission applications.

Universal design can be easily modified for varying applications resulting in system simplicity and flexibility. Manufacturing standardization assures quick delivery.

Optional plug-in audio-tone equipment permits transmission of data over voice or microwave channels where tone frequencies are required. Optional tone transmitter and receiver offer forty different tone frequencies available with conventional shift-type operation.

Completely transistorized system has *no* vacuum tubes. Telemeter transmitter, tone transmitter and receiver use only transistors in their circuitry. Telemeter receiver utilizes only diodes.

Compact System rack mounts—conserves valuable panel space.

Plug-in application adapters determine input range and output signals for both the transmitter and receiver. Plug-in filters and transformers select tone frequencies.

Combined accuracy of transmitter and receiver is ±0.5 percent of full span over these variations: ± 15°C temperature, ± 5 percent voltage change, ± 3 cycles frequency. A combined accuracy of ± 1 percent of full span is assured even when the transmitter is subjected to −20 to 55°C or ± 10 percent voltage change.

System stability—±0.5 percent of full span in six months plus ±0.1 percent of full span per each subsequent six months.

Quick response—system speed of response is rated 1 second for 99 percent of scale range—practically instantaneous. Such response is invaluable in applications involving load-frequency control wherein high-speed response is essential. In addition, there is no overshoot.

For utility telemetering in transmitting rapid fluctuation of electrical quantities such as watts, vars, volts and amperes . . . for fast positive transmission of industrial process data including quantities of pressure, temperature, liquid level, flow and many others . . . check into the cost saving advantages of G.E.'s new Analog Frequency System today. Your nearest G-E sales representative will be glad to provide you with additional information on this all-new low cost system. Be sure to ask for bulletin GEA-7163, or write direct to General Electric Company, Section 599-07, Schenectady 5, N. Y.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

Free literature

heat dissipation and sound ratings. Sorgel Electric Company

156 **Ventilated dry type transformer** specs: found in 8-p catalog 162. Units are rated from 600 v and below to 15,000 v; from 3 to 2000 kva. Niagara Transformer Corp

• Distribution and protection

157 **Cables** use butyl-base insulation that resists ozone, heat and moisture. Protective coverings and applications are chapters of 22-p booklet 1131. The Okonite Company

158 **Molded terminal boards,** sectional and 1-piece for panel and switchboard use, are described in 6-p bulletin GEA-7317. Lists kits for making up sectional boards. General Electric Company

159 **Steel-enclosed trolley busway** system bulletin 85 includes installation planning and procedure in its 44 pp. Feedrail Corporation

160 **100-amp bus duct** is described in 8-p brochure. Pictures construction and standard fittings. Westinghouse Electric Corporation, Standard Control Div

161 **Integral distribution centers** with liquid-filled and dry type transformers, 300 kva and up, are subject of 24-p catalog GEA-7222. General Electric Company

162 **Metalclad switchgear** is topic of two bulletins. 42-p GEA-5664F provides specifications for units in 2.4- to 13.8-kv and 75- to 1000-mva range. Installation of outdoor switchgear enclosures is detailed in 8-p GEA-7190. General Electric Company

• Application

163 **Ac-controlled** speed systems for range drives lets you adjust running motors. 4-p brochure F-2028 gives details. U. S. Electrical Motors Inc

164 **Ac and dc motors,** generators and control-equipment are subject of revised 48-p guide to electrical terminology — available from Fairbanks, Morse & Co, Electrical Div

165 **Safety magnetic motor starters** are described in 4-p folder GEA-7321. Photos show how to inspect or maintain with or without power interruption. General Electric Company

166 **Area floodlighting** 16-p guide 2719 is a reference for selecting incandescent or mercury floodlights. Includes footcandle charts and installation diagrams. Crouse-Hinds Company

167 **Single-phase,** 3-phase and dc motors are discussed in 16-p application guide 010. Other chap-

Begins on page 101A

ters: gearmotors, selective-speed drives. Century Electric Company

168 **Ac motors** from 1 to 2000 hp are self-greasing. Motor selection is covered in 16-p catalog B-2515. Reliance Electric and Engineering Company

169 **L-v synchronous-motor controls** are autotransformer or part-winding starting. 16-p booklet 3100-PRD-202 details methods using kva reduction. Electric Machinery Mfg Company

170 **Stainless-steel enclosures** are watertight — for manual and magnetic motor starters to 200 hp, 600 v. Spec sheet GEA-7324 is offered by General Electric Co

171 **Flexible electric motor couplings** are designed for transmitting power to pumps, compressors, generators and speed reducers. 6-p folder 2975 gives details. Link-Belt Company

Steam and hot-water systems

172 **Acid-resistant product** test methods and results are subject of 6-p folder. Protects brick, steel and concrete chimneys of plants using high-sulfur fuels. Benjamin Foster Company

173 **Checking air pollution** at the local level is discussed in 20-p brief. Chapters include legislation, training personnel and a proposal for a national coordinating organization. John Wood Company, Air Pollution Control Div

174 **Thermal dryer** for coal and other minerals is topic of 4-p circular 361. The McNally Pittsburg Mfg Corporation

175 **Retractable soot blower** has electric drive. 8-p bulletin 1063 diagrams double-helix-path cleaning. Blaw-Knox Company, Copes-Vulcan Div

• Heaters

176 **Vertical and horizontal tank heaters** boast 1-weld single-pipe construction. 8-p brochure 1623 is available from The Griscom-Russell Company

177 **Storage water heaters** are described in 8-p publication 1234. One section gives info on indirect gas-fired heater with 250- to 4000-gal storage capacity. The Patterson-Kelley Co, Inc

• Fuel and fuel handling

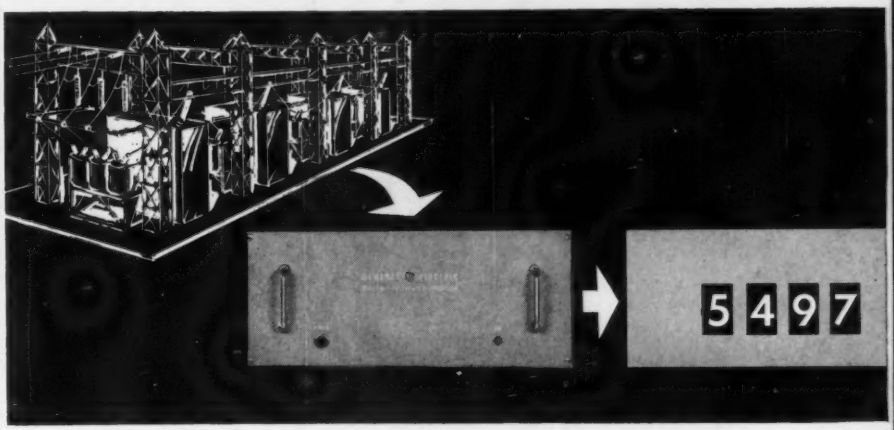
178 **Liquid fuel-oil additive,** used throughout system from storage tank to burner, reduces soot formation. Bulletin 461 is available from Universal Refining Products Company Inc

continued

NEW GENERAL ELECTRIC

Digital Telemetering

SYSTEM FOR FAST, HIGH ACCURACY DATA TRANSMISSION



For fastest, most accurate utility load or billing information, General Electric's all-new Digital Telemetering System brings kilowatt-hour information into load dispatching office over one channel, with *100 PERCENT ACCURACY.* Offers outstanding system values . . .

Flexibility: Digital telemetering signal can be time-multiplexed with an analog telemetering signal at a preset time interval, thus providing minimum channel expense and lower operating costs. Or the digital telemetering system can be used over its own isolated channel to transmit information on command. This system will also operate over any intermediate channel equipment capable of accommodating standard analog "frequency" telemetering signals.

Accuracy: Digital receiver self-checking feature permits only the read-out of correct numbers.The receiver will cancel the readout if there has been an incorrect code or interference of the coded signal during transmission.

Speed: Digital transmission is in the form of long and short pulses at average rate of 10 cps. A six digit number can be telemetered in less than five seconds.

Design: System utilizes time-proved relays and stepping switches that require minimum maintenance. No tubes or transistors are used. Equipment is furnished in 19-inch rack, dust-proof cases with slide-out drawers.

Cost: System price is usually less than the cost of comparable integrating devices which it now obsoletes.

Various read-out devices are available depending on your requirements. These include: electric typewriter, visual digital display units and tape punch equipment if you wish to use the information in a digital computer. Digital transmitters and receivers can be provided for either 4, 6 or 8 digit numbers.

For additional information on the all-new G-E Digital Telemetering System, just call your nearest General Electric sales office, ask for a copy of bulletin GEZ-3312, or write direct to General Electric Company, Section 599-07A, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Ltd., 940 Lansdowne Avenue, Toronto 4, Ontario.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

For more facts circle 257 on Reader Service card, p 101

Free literature

Begins on page 101A

179 **Trackside shakeout** is topic of 4-p folder 172. Pushbutton controlled, unit has 7½-hp vibrator drive and 3-hp hydraulic pump-motor specifications. Hewitt-Robins

180 **Bucket-elevator** system selection and application are subjects of 84-p manual be-55. Centrifugal and perfect discharge, continuous-bucket-elevator specifications are charted. Webster Manufacturing, Inc

• **Controls**

181 **Combustion controls** for furnaces, ovens and boilers are illustrated in 8-p catalog 3-001. Gas and furnace pressure, ratio and flow control are discussed. The North American Mfg Company

Fluid-handling systems

182 **Portable liquid loader** is detailed in data sheet PNB 3-61 available from OPW-Jordan Corporation

• **Water treatment**

183 **Treatment** of boiler- and cooling-water systems: subject of 4-p maintenance and troubleshooting checklist CS 113. Lists diagnosis scaling, corrosion and foaming. Ionac Chemical Company

184 **Automatic analysis** of aldehydes and total acidity are topics of two data sheets. Flow diagrams show analysis. Technicon Controls, Inc

185 **Biocides** for algae and slime control are covered in data sheet available from Western Chemical Company

• **Pumps**

186 **Canned - pumps** performance curves are plotted in fact sheet 1051-1 from Chempump Div, Fostoria Corporation

187 **Vertical-duplex** and horizontal-triplex pumps handle 100 to 10,000 psi and 500 F. Data is available from John Bean Div, Food Machinery & Chemical Corp

188 **Multistage centrifugal pumps** with 2600-gpm capacity and 1200-psi working pressure are covered in 8-p booklet 722.4. Goulds Pumps, Inc

• **Controls**

189 **Adjustable-** and differential-pressure switch is used in fluid systems operating to 250 psi. Unit uses magnetic transmission, eliminates mechanical linkages. Spec sheet E8 is available from Pall Corporation

190 **Stainless-steel** temperature regulators are suitable for steam, water, air, oil and gas service. In cast steel, units handle 300-psi wsp and 500 F. Data sheets JNP-6 and SRBc 27-61 give details. OPW-Jordan Corporation

Wait no longer . . .

enjoy the benefits of leasing a Plibrico Incinerator now

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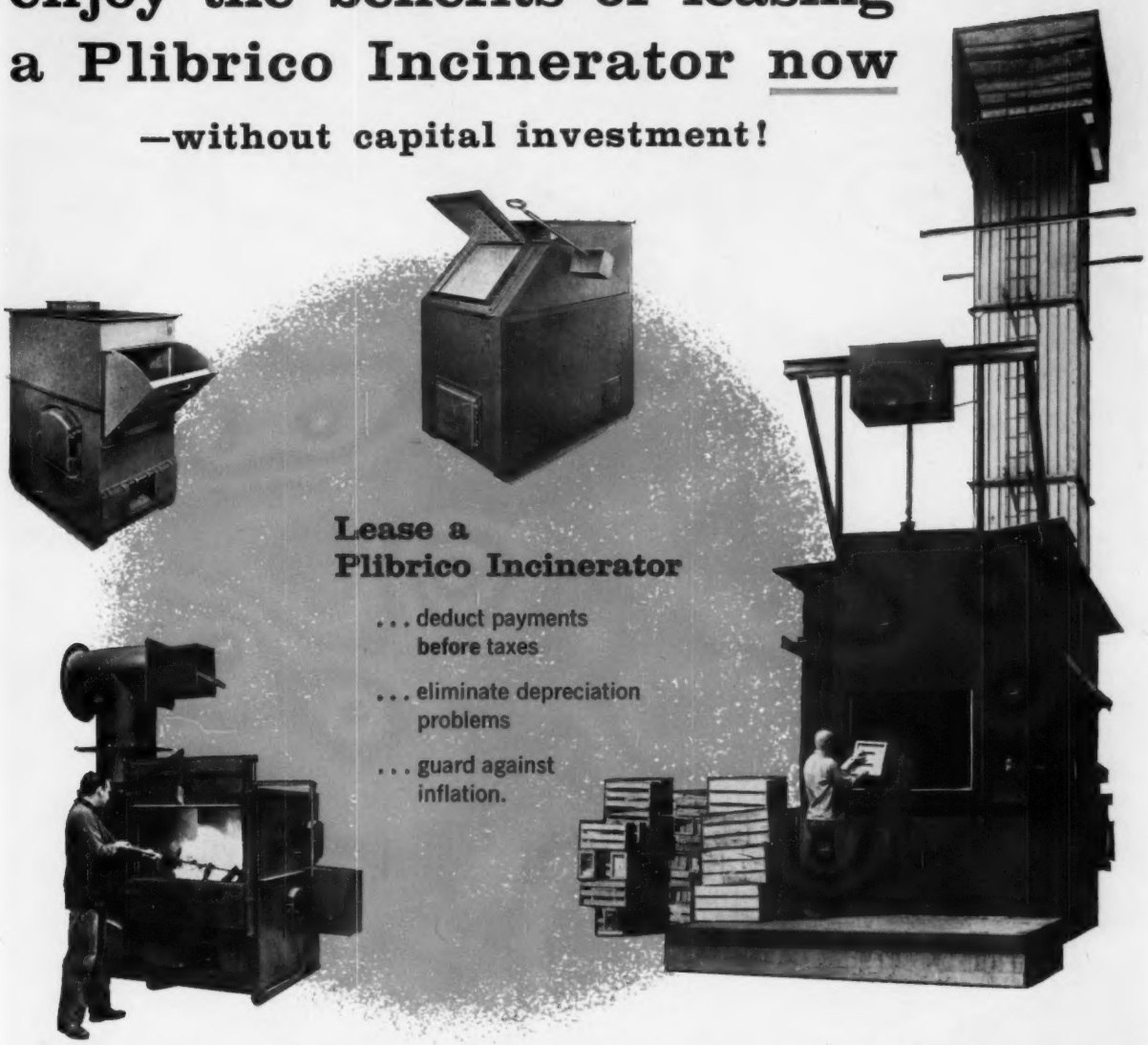

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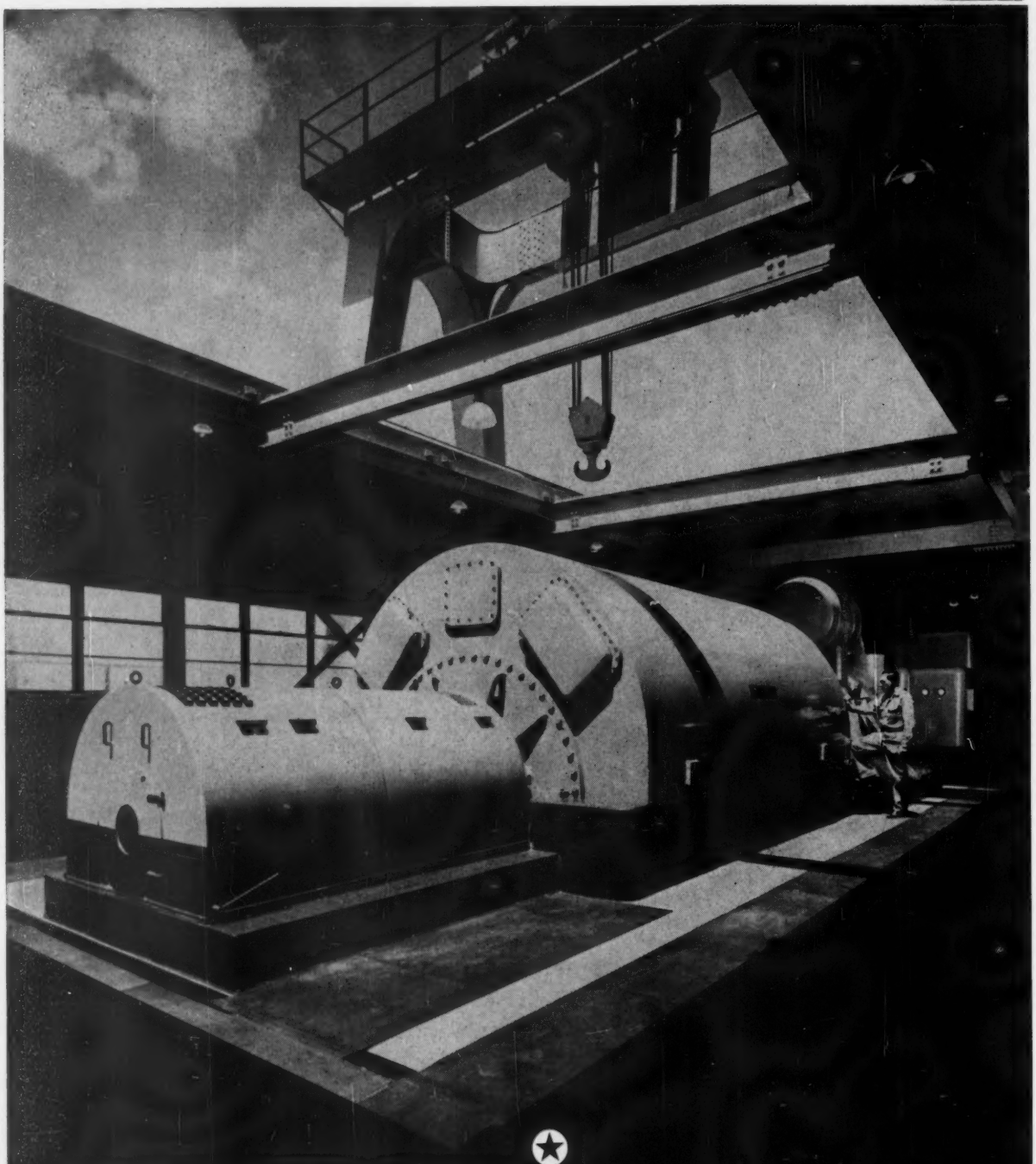
WRITE FOR LEASING DATA giving all details and Catalog 63 describing all models.

For more facts circle 259 on Reader Service card, p 101



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The configuration of semi-outdoor installations typifies the economics of design incorporated in Stearns-Roger built steam power plants. From 75 years of service to industry, Stearns-Roger provides complete engineering and construction of efficient power facilities. Your power plant is our business.

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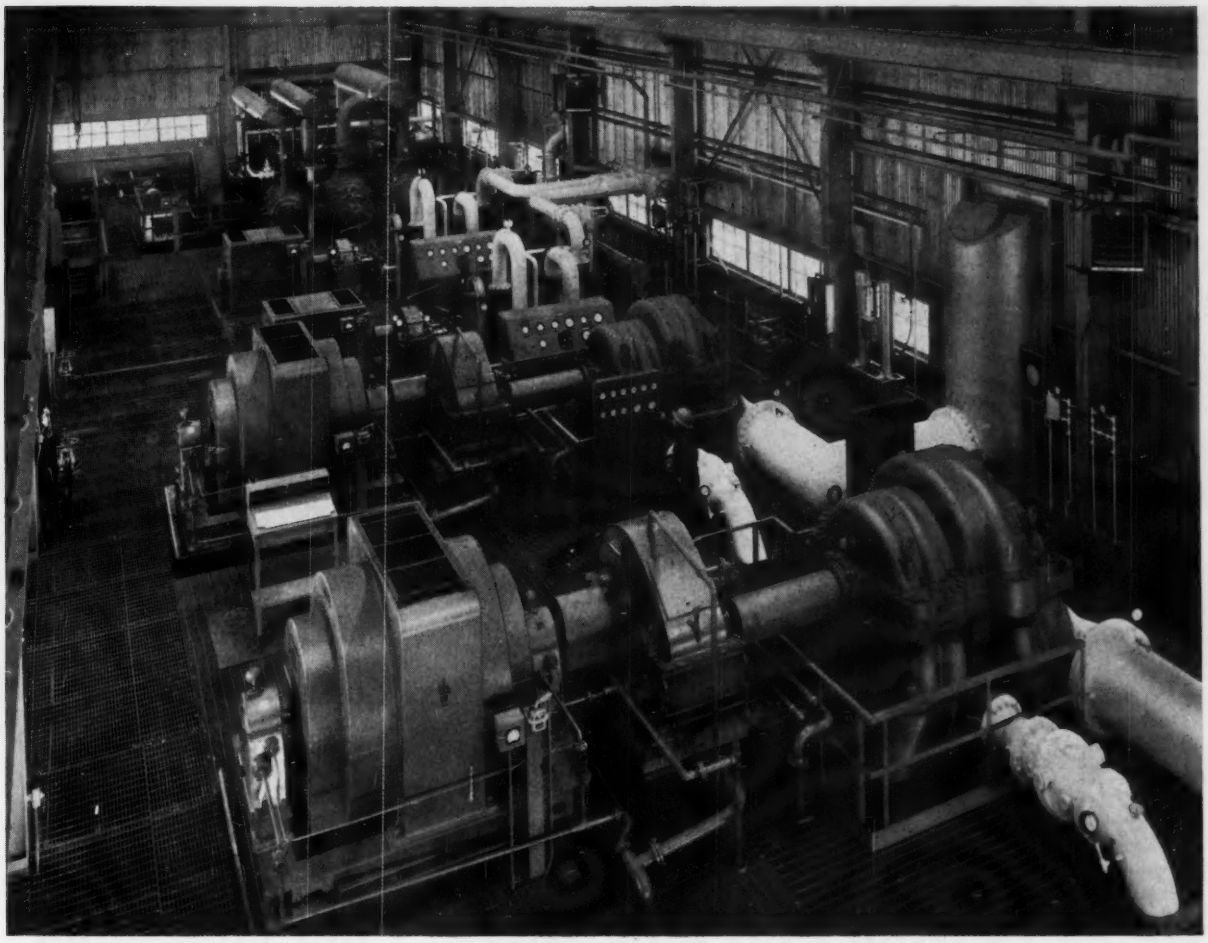
"The relative disposition of parts" —Webster

NEW CENTRIFUGAL AIR COMPRESSORS BY CLARK

The plus factor in modern oxygen plants for steelmaking



One good reason why so much U. S. oxygen capacity for steelmaking is handled by Clark compressors, is the ability of Clark engineers to develop complete compressor systems.

A typical steel mill oxygen plant installation is pictured above. In addition to being equipped with four proven Clark centrifugal oxygen compressors and a non-lube reciprocating unit handling nitrogen, this plant uses the new Clark *IsoTemp* centrifugal air compressor. Two of these machines are shown handling "100 lb. air" in the first stage of air separation.

Twenty-five *IsoTemp* compressors have been purchased for installation throughout the world after a careful analysis of features by informed U. S. and European engineers. Among the factors which influenced their choice: Four-stage, isothermal type design; the use of integral base-mounted intercoolers between each compression stage for maximum efficiency; low installation cost as a result of compact design; isolated bearing chambers combined with a unique seal porting system to eliminate lube oil contamination of the compressed air stream.

The user's confidence in the reliability of the new Clark *IsoTemp* is well founded. These machines have met all predicted performance guarantees and have proved trouble-free in every respect.

Clark Bros. Co. has unusually broad experience in the manufacture of all types and sizes of centrifugal and reciprocating compressors. If you are considering expansion, let Clark engineers help you plan for the most profit.

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CLARK® DRESSER INDUSTRIES INC.

OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

PPG Fiber Glass Pipe Insulation is slit lengthwise, slips easily on to pipe. Delaware Insulation Company installed 15,000 ft of PPG Pipe Insulation in the new Wilmington High School, reported excellent working characteristics.

"We can install PPG Fiber Glass Pipe Insulation 15% faster than other pipe insulating materials"

says Mr. Anthony Kotowski, foreman, Delaware Insulation Company, Wilmington, Delaware

"A good worker can insulate 200 feet of pipe in one work day. But with PPG Pipe Insulation, he can insulate 230 feet in the same amount of time," reports Mr. Kotowski. "This helps us maintain tight construction schedules and saves money, too!

"We like PPG Fiber Glass Pipe Insulation because it's flexible and workable. We bend it around pipe hangers, mold it to shape easily, smooth it, then fasten and bind it," continued Mr. Kotowski as he discussed the PPG installation in a Wilmington High School. "You can't do that with other insulations. They're too brittle, require cutting, and sometimes break when you're working with them.

"PPG Pipe Insulation is easy on the hands, and it's not attacked by rodents. Of all the insulations on the market, PPG gives the neatest, quickest job."

GET TOP RESULTS WITH PPG

Fast installation, excellent thermal insulation, long service life, low maintenance . . . all these advantages are yours with PPG Fiber Glass Pipe Insulation. It's available in a full range of sizes, with or without facing.

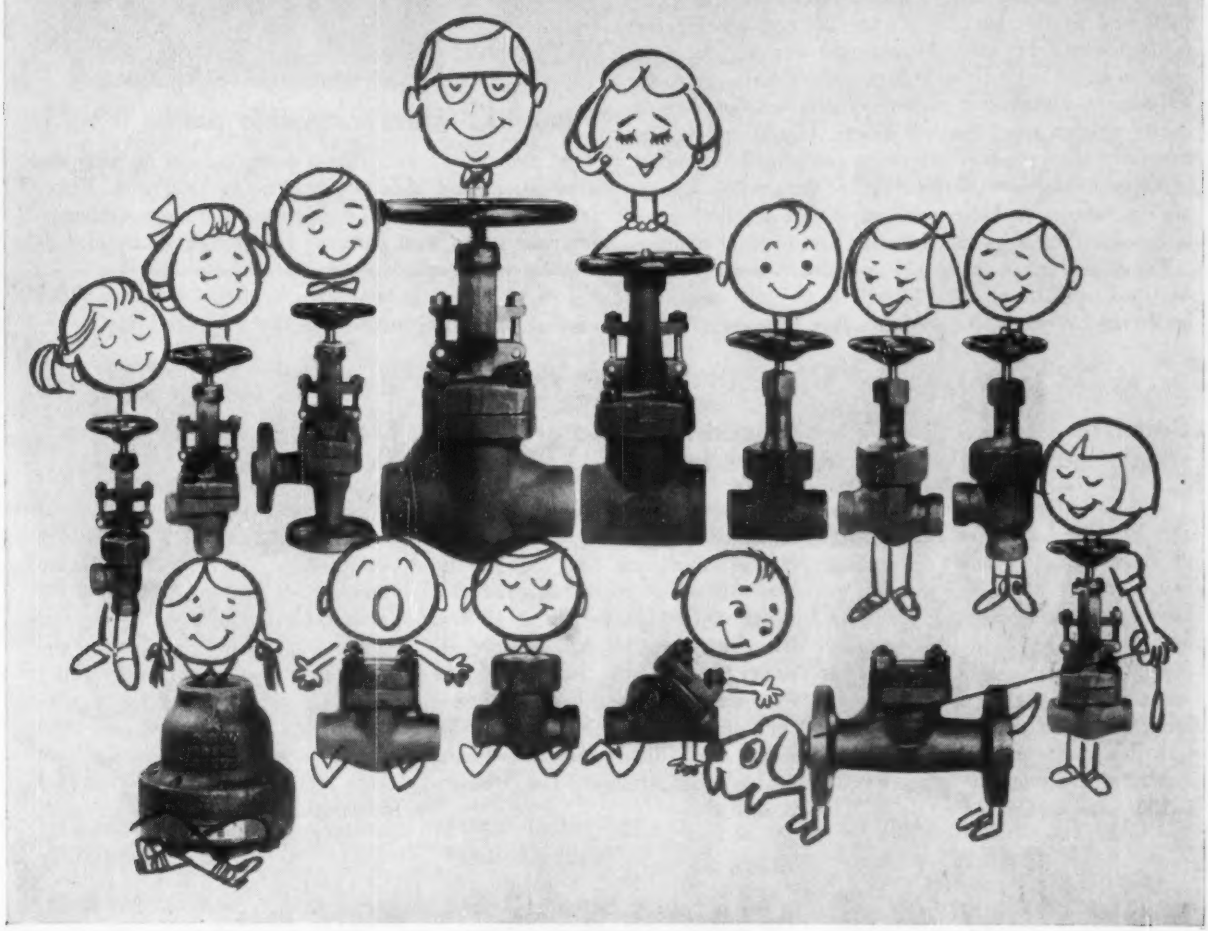
For full information, contact your nearest PPG Fiber Glass Sales Office, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Penna.*

FIBER PG GLASS PITTSBURGH PLATE GLASS COMPANY

Sales Offices: Atlanta, Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Houston, Kansas City, Louisville, Los Angeles, Miami, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis and Seattle.

For more facts circle 262 on Reader Service card, p 101

CRANE'S LARGE FAMILY OF SMALL STEEL VALVES



CRANE 600-POUND STEEL GATE, GLOBE, ANGLE AND CHECK VALVES—¼" TO 2" SIZES—

gathered together for their first family portrait, from thousands of flow control assignments in every industry. In forged and cast steel; bolted and union bonnets and caps; outside screw and yoke or inside screw; Exelloy, Stellite*, Type 316 Stainless, Monel trims; reduced and full ports; screwed, flanged and socket-welding ends—one or more will meet every specific need. All share the Crane family trait of superior design, ruggedness and fine craftsmanship.

*Stellite is a registered trademark of Union Carbide Corp.

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plumbing • heating
air conditioning

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Plant equipment news... Your

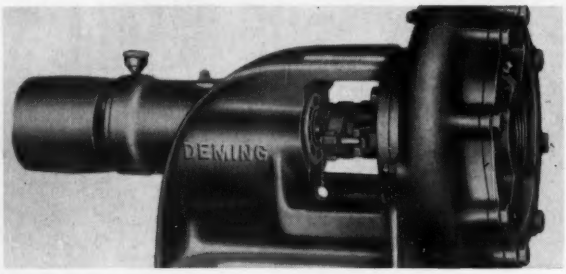
For more data on these developments, circle key numbers on Reader Service card, p 101

Metering pump now adjusts at forward end of stroke

1 • Low-flow controlled-volume metering pump serves in liquid-chemical-feed systems. Pump's speed reducer and drive unit convert high-speed rotary motion into low-speed reciprocating motion with a minimum of working parts and bearing surfaces. Connecting-rod bearings are continuously lubricated. All enclosed working parts operate in an oil bath. Drive unit provides 0-to-100% stroke adjustment without lost motion—this makes resulting capacity change approximately linear. Liquid end is continuously scavenged to minimize compressibility effect.

Adjustment is from forward end of the stroke—plunger always returns to same position at top of crank revolution—so there's less compression loss of fluid pumped.

Capacities range from 0.89 gph for pressures up to 4470 psi to 88.0 gph for 170 psi. Up to nine pumps can be driven by one motor.—Milton Roy Company



Pump has interchangeable parts

2 • End-suction centrifugal pump adapts to different applications and handles capacities to 3000 gpm. Power frames take a variety of liquid ends and motors, increasing capacity to meet pumping requirements. Liquid ends may be cast iron, all bronze, stainless steel or alloys.

In case of normal impeller wear, impeller design allows easy on-line adjustment.—The Deming Company

Camera goes where man can't

3 • Television system for line inspection is submersible, has its own lighting system. Camera is pulled through pipe—sometimes as small as 4-in. ID—by a cable. Technician watches monitor in mobile viewing room, phones speed and movement instructions to an operator. Area of break shows on monitor and technician determines exact location from length of cable in the pipe. Price: $6500.—Inspectoline, Inc

Finned-tube heater bows in

4 • Horizontal heater weighing 170 lb can be installed singly or in banks. Helical aluminum fins lock tightly into pipe for good heat transfer. Aluminum's high coefficient of heat transfer results in high heating capacity per ft of pipe. Two finned pipe sections welded together form one continuous length. Single tube assures even distribution of steam, avoids cyclic stresses.—The Griscom-Russell Co

Exchanger eases cleaning job

5 • Floating-head clamp-ring heat exchanger has removable bundles. Design makes tube cleaning easy and permits high thermal differential expansion. Pre-engineered units handle liquids and gases—even toxic, volatile or flammable combinations. They also serve as heaters, coolers, condensers or vaporizers. Shell- and tube-side design pressures range from 75 to 300 psi.—American Standard Industrial Div

Television serves as watchdog

6 • Closed-circuit television system—transistorized camera, pickup tube and separate camera-control and power-supply unit—keeps an eye on things in the plant. The 7¾-lb camera has a 25-mm f 1.9 lens. Designed for complete remote control, system can be portable or operate as an automatic permanent installation. Intercom equipment is optional. Price is $695.—Packard Bell Electronics

Additives up fuel-oil heat value

7 • Fuel-oil with additive burns more uniformly, reducing smoke. Two formulas are available, for No. 2 to 5 fuel oil, and for No. 6 or Bunker-C oil. Formula is added on top of the oil—1 gal to 1000 gal of oil, and disperses through entire supply including oil added later. Additives dissolve sludge; then sludge mixes with lighter oil so its high Btu value can also be used.—Solar Chemical Company

Heater uses cast-steel headers

8 • Storage-tank heater's cast-steel headers provide high corrosion allowances. Outlet header has concave bottom; it serves as a trap to collect steam condensate, then drains it out. Finned tubes provide more heating surface per ft than bare pipe, maker states. Result: more heat transfers at lower skin temperatures, preventing coking on tubes or polymerization.—Brown Fintube Company

information center for new products and materials

Pump's liners are renewable

9 • Turbine pump is designed for booster service up to 60 psig in suction on boiler feed, condensate return, transfer or circulation lines. Maintenance-free mechanical seals can be chosen where weekly maintenance of packing isn't possible.

Pump comes in 85 sizes. Maximum limits: 160-psig discharge, 60-psig suction, 110-psig for the mechanical seal and 210-F temperature. Liners are renewable for easy field repair.—Roy E Roth Company

Maintenance on pump is easy

10 • Packaged close-coupled end-suction centrifugal pump is compact, requires less space. Unit can be disassembled completely without disturbing the suction or discharge piping. It vents itself, eliminating the possibility of vapor lock and providing smooth, quiet operation. Stainless steel eliminates deflection and assures longer seal life, maker claims. Capacities range up to 400 gpm, with heads to 150 ft.—Aurora Pump Div, New York Air Brake Company

Valve seat won't gall

11 • Install this self-draining valve when you want the valve seat inside the pipe or vessel wall. No liquid remains between the liquid container and seat when valve is closed.

Threaded part of stem is outside the valve body—it's not affected by temperature of the liquid. Stem goes to or from the seat in a straight line, giving good seating every time. This, maker claims, eliminates problem of seat wear because of galling.—Jerguson Gage & Valve Co

Condenser has V-shaped coils

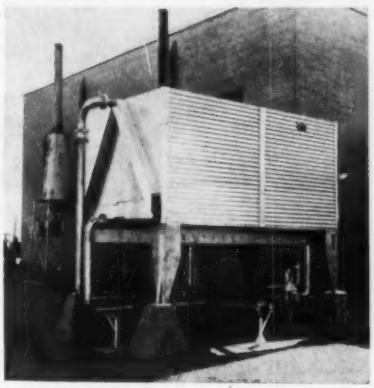
13 • Remote air-cooled condenser's coils are arranged in a V. Air is drawn through the coils and discharged straight up by the propeller fans. This provides a low silhouette in minimum floor space. The 3- to 10-ton-capacity unit has direct-drive fans, totally enclosed motors and lightweight corrosion-resistant aluminum cabinets.—Halstead & Mitchell Company

Vent and skylight are one unit

12 • Safety vent for heat, smoke and explosion relief has large glass-fiber windows. This saves buying and installing two separate pieces. Installation is entirely above the roof. Combination skylight-vent has a quick release chain for manual operation. Handles let you open it from the roof without disturbing the release mechanism. Open dampers are held vertical.—Swartwout Fabricators, Inc

Fans come in two models

14 • Compact, forward-curved centrifugal fans are suited for systems having limited space or low noise requirements. Fans come in two models, for 300-F maximum or for 2000-F hot-air or -gas service. 2000-F fan is designed for direct furnace installation without external ductwork. Wheel sizes; from 7½- to 73-in. dia. They're belt-driven or direct-connected.—Garden City Fan & Blower Co



Dryers adapt to any location

15 • Dryer-coolers use vertical-forced-draft air flow and diagonally mounted coil sections for maximum heat rejection. This permits efficient operation regardless of prevailing air currents. Damper controls keep temperatures uniform during low ambient dry-bulb periods. You can dial the fluid temperature and hold the cold-fluid return temperature within close limits.—The Marley Company

For more data on these developments, circle key numbers on Reader Service card, p 101

With W & T Treatment Equipment

Now you can take the sting out of cooling-water contaminants, solve treatment problems with chlorinators and pumps by Wallace & Tiernan.

For biological control there's intermittent desliming.

W&T chlorination kills slime and spores, never lets growth affect heat-exchange capacity. Job-proportioned V-notch Chlorinators feed up to 8,000 lbs. of chlorine per day. Treatment is efficient and economical. You get reliable control. Heat-exchange surfaces stay slime-free.

For pH and corrosion control there's chemical feeding.

The Wallace & Tiernan Series 100 Pump feeds chromates or acids at rates of up to 50 gph or boiler-treatment chemicals against pressures up to 1200 psi. The pump's unitized construction means lifelong accuracy, reduced maintenance. Choose one or two liquid ends, with individual stroke adjustment, to double capacity or feed two chemicals simultaneously. Where high pressures are not a problem, W&T Diaphragm Pumps also give reliable feeding of 1 to 500 gpd. Heat-exchange surfaces stay corrosion-free.

With Wallace & Tiernan Chlorinators and Pumps you keep condenser tubes clean and sound, assure heat-exchange efficiency.

For more information, write Dept. S-149.76.

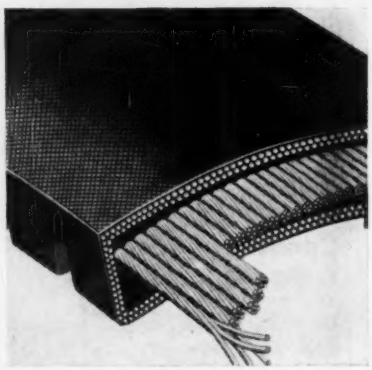
WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

Equipment news

Instant-mix concentrates for magnetic particle testing

25 • Powder concentrates for the wet method of visible and fluorescent crack detection feature easier mixing, handling and storage; more fluorescent brilliance; less foaming; better corrosion protection. You can add these concentrates directly to your tank of oil or water, above. They go into uniform suspension almost immediately, says manufacturer.—Magnaflux Corporation

Just circle key numbers on the Reader Service card, page 101, to get complete product story



Variable-speed belts

42 • Top widths of standard sizes range from 7/8 to 3 in., nominal overall lengths from 26.4 to 170 in. Construction is said to withstand intense squeezing action of pulley-sheave walls, provide smooth transmission at full power.

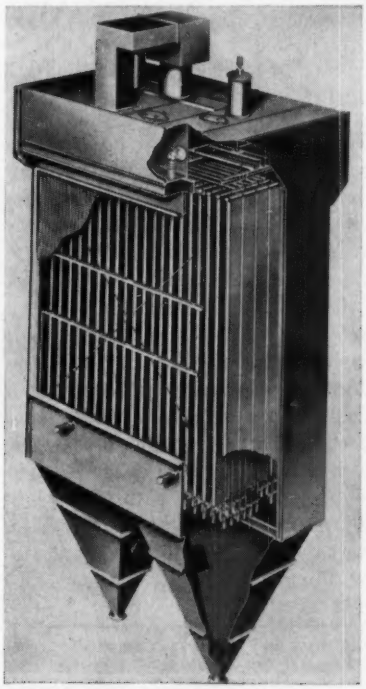
Belts are made of fiber-reinforced synthetic rubber—impervious to oil and heat, maker states. Uniform

Begins on page 114

notching on underside gives flexibility without great strain or distortion on small-pulley applications. —Lovejoy Flexible Coupling Co

1%-zirconium-columbium tubes for nuclear reactors

26 • Small-diameter tubing is now available in 1%-zirconium-columbium, an alloy which resists oxidation better and is stronger at high temperatures than unalloyed reactor-grade columbium. Applications will be fuel-element cladding, heat-exchanger tubing. Stress-relieved at 1800 F, the alloy has these mechanical properties: maximum tensile strength, 75,000 psi; maximum yield strength (2% offset), 60,000 psi; minimum elongation (in 2 in.), 12%.—Superior Tube Company

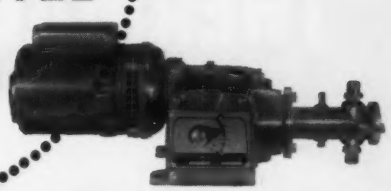


Precipitator features flat collector plate

52 • Custom-built electrostatic-precipitator units are preassembled in plant, simplifying field erection.

Nonwelded flat collector-plate design lowers possibility of warping,

NOW, GET BIG PUMP FEATURES IN A SMALL PUMP



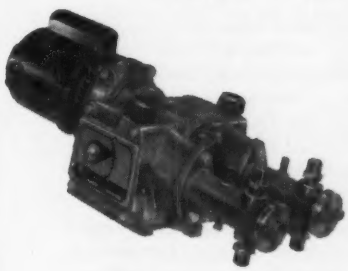
The New W&T Series 100

The Wallace & Tiernan Series 100 Metering Pump borrowed its design from W&T's Heavy Duty Pumps. Big-pump features are retained. Only size is scaled down for jobs like boiler-feed-water treatment.

The Series 100 Pump is one enclosed unit. There are no exposed moving parts. Motor and drive transmit thrust in a straight line. Pumping forces are absorbed by the heavy gear case. There are no rocker arms, no base-plate loads to twist components out of alignment.

Spring-loaded stuffing box assures proper pressure on the packing, prevents over-tightening, automatically adjusts for wear. Packing is easily replaced.

Stroke length is adjusted over a 10 to 1 range while the pump is running. Even in the double simplex, each liquid end is individually adjusted.



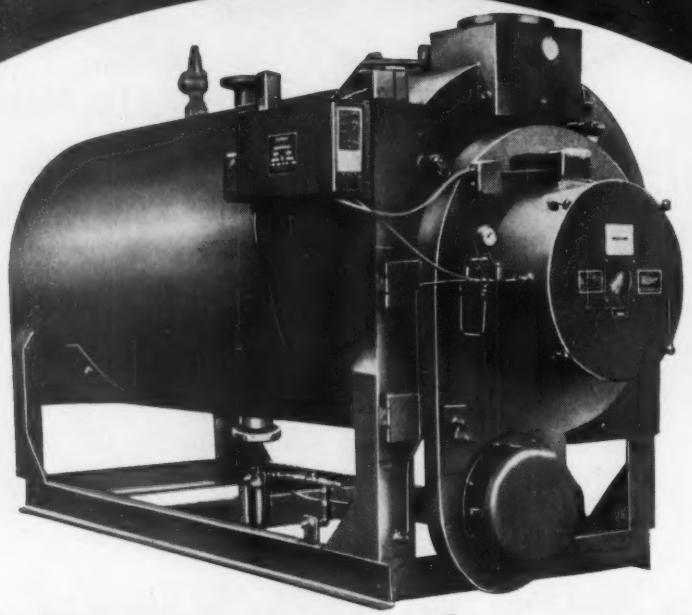
The Series 100 Pump delivers 3.2 gph vs 1200 psi, 50 gph vs 100 psi, repeatable within ±1%. You get big-pump performance at a small- capacity price.

For more information, write Dept. L-10.76.

WALLACE & TIERNAN INC.
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

For more facts circle 265 on Reader Service card, p 101

GUARANTEED against damage from "THERMAL SHOCK"!



Continental 2-PASS

AUTOMATIC HOT WATER BOILERS

575,000 BTU to 23,435,000 BTU

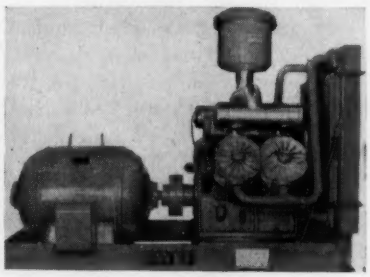
Continental Boilers in hot water service have established an outstanding performance record—*no* failures or damage from thermal shock have occurred among *all* units in service. Low, medium and high temperature operation is included in various system designs and under widely varying seasonal conditions. This proven performance has resulted in Continental Boilers being approved and specified in ever-increasing numbers by design engineers.

Now the positive assurance which stems from these years of trouble-free service has led to an unprecedented *3-year guarantee* against thermal shock damage. Continental's "code-plus" construction methods and unique adaptation of 2-Pass design deserve your further investigation. Send for details of new guarantee and Bulletin BE-200.

CONTINENTAL BOILER Division
BOILER ENGINEERING & SUPPLY CO., Inc.
Phoenixville, Pennsylvania
Nationwide Sales and Service in Principal Cities

works where resistivity is high. Results: improved clean-plate sparking voltage, increased dust-particle migration velocity to collector plate, maker states. Plate has pockets which trap and hold dust, reducing chance of re-entrainment.

Unit is modular, all-welded. Structural frames, side casings, end panels and hoppers are heavy-gage steel plate. Silicon, selenium, h-v vacuum-tube or mechanical rectifiers are available. — American-Standard Industrial Div



Compressors are single and 2 stage

51 • Reciprocating air compressors range from 7½ to 150 hp. Direct-connected and V-belt-driven machines are available. Single-stage compressor is for operation at 50-psi, 2-stage at 125-psi continuous pressure.

Individual cylinders of nickel-iron alloy feature deep radial fins for best cooling and low operating temperatures. Suction-valve unloaders hold intake valves off seats when pressure reaches maximum setting. When pressure drops ten psi, valves are released to operate from an adjustable pilot-control valve. Controls are automatic start-stop or dual.—Davey Compressor Company

Just circle key numbers on the Reader Service card, page 101, to get complete product story

Grease spray protects insulators

55 • Insulating silicone-base grease is designed to protect insulators from effects of atmospheric-contamination deposits. Previously applied by hand methods, grease is now sprayed at

He's gunning B&W KAOCRETE-D ...the refractory castable that withstands punishing ashpit service

Relining ashpits in stoker-fired or pulverized-coal-fired boilers is expensive and time-consuming. To reduce maintenance in this severe service, B&W has developed durable Kaocrete-D, a refractory castable which can be wet or dry-gunned into place — or cast using modern materials handling methods. It withstands the punishing effects of abrasion, erosion and spalling in virtually every ashpit design.

Widely used in all types of boiler ashpit hoppers and slag tanks, Kaocrete-D has proved its economy and durability. Where abrasive and erosive conditions are less severe, B&W Kaocrete-A will give satisfactory service.

Cut the frequency of maintenance and expensive relining jobs by using heavy-duty B&W Refractory Castables. Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits. Write to: The Babcock & Wilcox Co., Refractories Division, 161 East 42nd Street, New York 17, N. Y.

R670

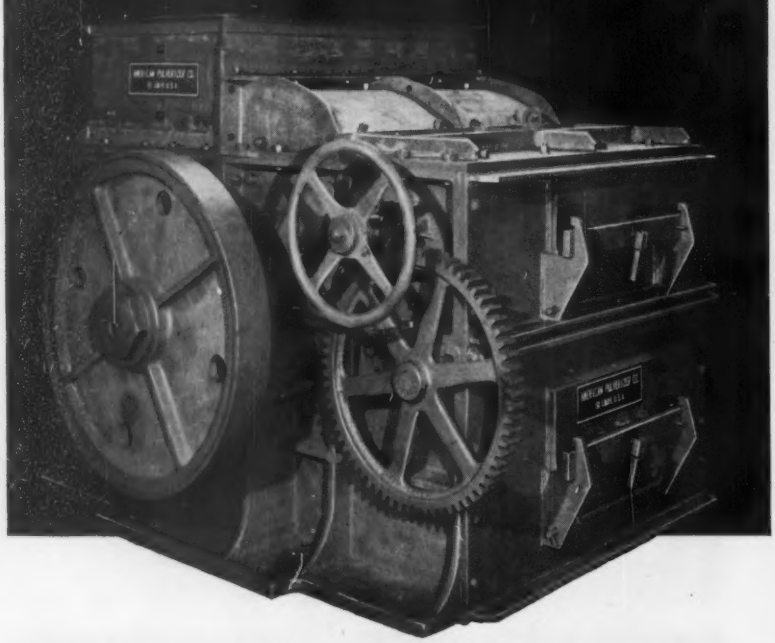
B&W

THE BABCOCK & WILCOX COMPANY

REFRACTORIES DIVISION

B&W Firebrick, Insulating Firebrick, and Refractory Castables, Plastics, Ramming Mixes, Mortars, and Ceramic Fiber.

American Coal Crushers are RUGGED!



Soundly engineered and constructed to give you many years of high volume crushing at low operating costs.

1. Oversize bearings.
2. Alloy Steel heat treated rotor shaft.
3. Heavy rib reinforced housing with renewable liners and tramp metal pocket.
4. Manganese Steel crushing elements.
5. Exclusive American-Originated rolling shedder ring which splits coal instead of crushing it.
6. More efficient crushing design which permits slower operating speeds and less power consumption per ton of coal crushed.
7. Dual adjustment to give flexibility of size control and to compensate for wear.
8. Maximum flexibility of rolling ring rotor prevents injury from tramp iron.
9. Full width screening area gives faster discharge of reduced product.

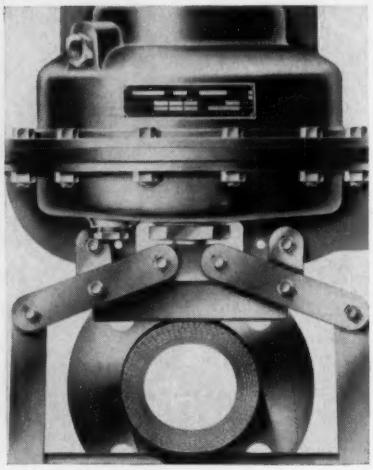
Coal Crushers exclusively, from Sample Crushers to Capacities of 800 TPH
Write for literature stating capacity you need.

American PULVERIZER COMPANY
PULVERIZERS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS
1349 MACKLIND AVE. SAINT LOUIS 10, MISSOURI

Equipment news

Begins on page 114

any desired thickness. To prevent electrolyte formation in fog or rain, coating engulfs contaminant particles. It provides a nonwetting surface to shed moisture. When grease becomes saturated with contaminants and leakage and arcing begin, it breaks down into nonconducting vapor and white silica powder to maintain high-resistance surface.—General Electric Co



Valve operates in hazardous locations

56 • Flexible valve controls highly abrasive slurries and corrosive materials in inaccessible locations. Anything that flows through pipe will flow through valve's pipelike body, maker claims. Clean it by tapping with a mallet; flexible body absorbs vibration, is unaffected by water hammer.

Valve is available in rubber and compounds, in sizes from 1 to 12 in. Diaphragm motor permits automatic control.—Farris Flexible Valve Corp

Just circle key numbers on the Reader Service card, page 101, to get complete product story

Submersible 8-in. pump boasts high capacities

31 • High-efficiency submersible aims to meet demands of industrial, commercial and municipal water supply. Series F comes in 10- through 50-hp sizes, with capacities from 150 to 550 gpm. One feature: bronze

new Yarway Unit Tandem Valve for blow-off service up to 665 lbs. WSP ...provides proven Yarway Unit Tandem dependability for medium pressure installations. Streamlined, light in weight, easy to operate, tight sealing, with minimum maintenance.

Ask for free Bulletin B-435, Supplement A

YARNALL-WARING COMPANY • 100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

TIGHT
Sealing valve is time-proven Yarway Seatless design.
TOUGH
Blowing valve features stellite-faced disc and integral stellite seat.
TRIM
Both valves, mounted together, permit more compact piping with reduced weight.

A FEW OF THE MANY SATISFIED USERS: U. S. Sugar Corp. • West Point Mfg. Co. • Halifax Paper Co. • R. J. Reynolds Tobacco Co. • Pulp and Paper Co., Colombia, S. A. • Western Electric Co. • Cornell University

For more facts circle 269 on Reader Service card, p 101

DRAFT SHORTAGES?

REPLACE THE DRAFT
DIVERTERS ON YOUR
GAS FIRED BOILERS

WITH DOUBLE-ACTING
FIELD DRAFT CONTROLS*

to overcome draft shortages, permit increased firing rates

*Field makes the draft assistance of the chimney available to the boiler for abundant draft at all firing rates, precisely controlled to the optimum twelve-to-one air-to-gas ratio recommended for clean, efficient combustion. Write for engineering data.

FIELD CONTROL DIVISION
Conco Engineering Works, Inc., Mendota, Illinois
AFFILIATES:
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For 5"—34" Flues

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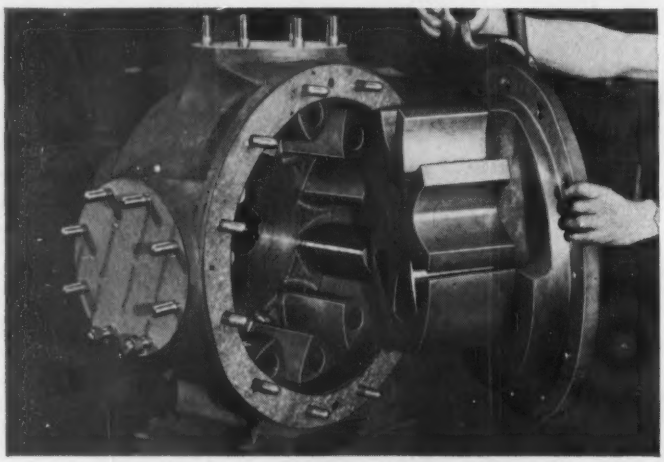
GEARED TO HANDLE PUMPING PROBLEMS

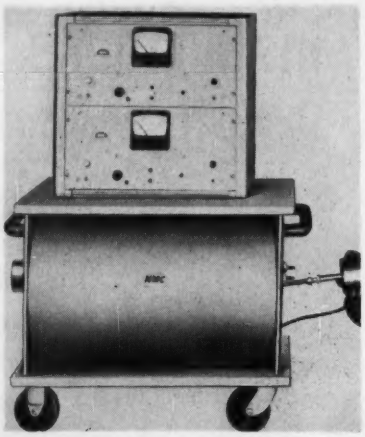


THE VIKING "GEAR-WITHIN-A-GEAR" PUMPING PRINCIPLE helps engineers solve a wide range of pumping problems throughout the world. In the petroleum industry, chemical processing, food processing, meat packing, road building and many other industries, VIKING PUMPS handle liquids and semi-solids efficiently and at low cost. And VIKINGS pump liquids ranging from thin, liquefied gas to thick, viscous tars. Originated 50 years ago, the VIKING pumping principle has been adapted so successfully to so many applications that VIKING is now the largest exclusive rotary pump manufacturer in the world.

You men who specify and buy rotary pumps, can select from a complete size range of VIKING PUMPS, from ½ to 1050 G.P.M. in over 850 catalogued models and thousands of special designs. If you have a pumping problem, tell us . . . and ask for catalog 61SW.

VIKING PUMP COMPANY, Cedar Falls, Iowa, U.S.A. In Canada, it's Roto-King" Pumps. See Our Catalog In Sweet's Industrial Construction and Plant Engineers File.

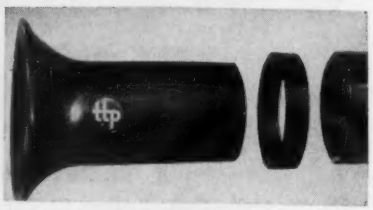
bowls and impellers to boost corrosion and wear resistance. Impellers are connected to a stainless-steel shaft which runs in rubber bushings.—Sumo Pumps, Inc



System measures radioactivity in gas, water

59 • Fluid-monitoring system detects and measures radioactivity in stack gases, cooling loops and effluent-fluid lines discharging to sewer or holdup tanks. It consists of a mobile sampling tank and logarithmic-count ratemeter. Two detectors operate together or separately. — Nuclear Measurements Corp

Just circle key numbers on the Reader Service card, page 101, to get complete product story



Plastic pipe fitting has belled end

57 • Fittings for ends of underground thermoplastic pipe conduits make it easier to insert power cables. Fittings are of plastic to match piping. Bell-shaped end flares to about twice OD of pipe. Other end is normal pipe size; you couple it to runs

For more facts circle 271 on Reader Service card, p 101

Circle 272 on Reader Service card for this ad ➤

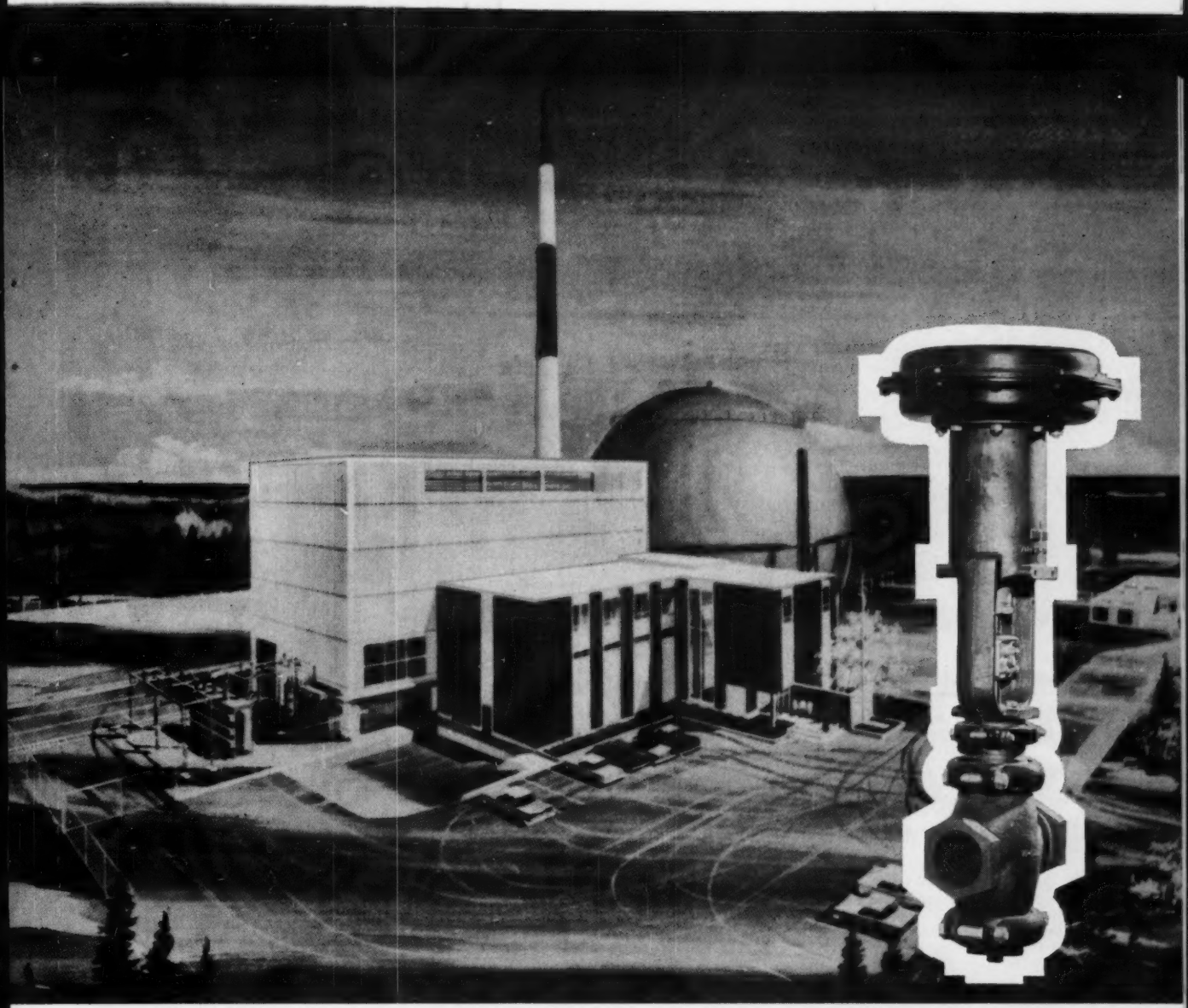


IMAGE OF TOMORROW AT Big Rock

On a 600 acre site four miles northeast of Charlevoix, Michigan, Consumers Power Company is building a new Nuclear Electric generating plant. The reactor system is designed to develop 964,000 pounds of saturated steam per hour at a pressure of 1470 lbs. per square inch. The plant will develop a maximum gross electrical capacity of 75,000 kilowatts.

Consumers Power and General Electric, in cooperation with the U. S. Atomic Energy Commission, will use Big Rock Point as an experimental station to conduct research on nuclear fuels. Thus, from Big Rock Point will come valuable information for all of America's power companies.

We at BS&B are proud of our part in the Big Rock Point Nuclear Power Project.

If you are planning expansion, BS&B has a technical service group with a wealth of power background that can help you with valve application. Contact: Black, Sivalls & Bryson, Dept. 4-Q7, 15 North Cincinnati, Tulsa, Oklahoma.

BS&B

BLACK, SIVALLS & BRYSON

TULSA • OKLAHOMA CITY • KANSAS CITY • EDMONTON • THE HAGUE

VOTE HERE

what use can you make of this

DIAPHRAGM VALVE?

Check one or more of the following

- ☐ As a power-operated line valve of any kind, normally-open or normally-closed, with better-than-average low pressure-loss and high flow-rate characteristics.
- ☐ As a remotely-operated flow-control valve in an inaccessible location where reliability and long life are important.
- ☐ As automatically-controlled units in a complexity of flow circuits, where rapid and certain response to control signals is significant.
- ☐ As a large power-operated control valve where the actuating power is the actual line pressure, and release is accomplished by simply bleeding this pressure to drain with a small solenoid, pneumatic, or manual valve.

INSTRUCTIONS

1. After "voting," write your name, company, and address in the margin.
2. Tear out this Ad and mail to:

AquaMatic INC.

2402 GRANT AVE., ROCKFORD, ILLINOIS

ENGINEERED WATER AquaMatic CONDITIONING CONTROLS

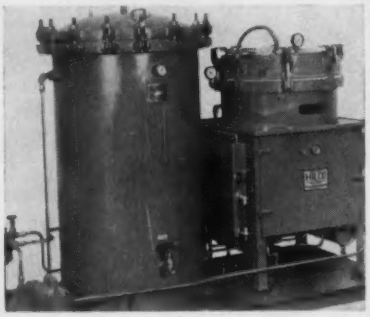
circle 273 on Reader Service card, p 101

Equipment news

Begins on page 114

of plastic pipe guarding power lines against corrosion.

Thermally welded ring around fitting body anchors piping in cement casing.—Tube Turns Plastics Inc

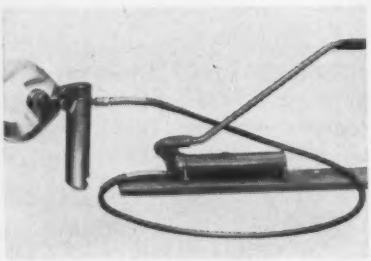


Combination filter and reclaimer

62 • Motor-pump set forces oil through filter. All or part of oil is diverted to reclaimer for final polishing and removal of moisture, water and other volatile contamination.

Piping is arranged so reclaimer or filter can operate alone where straight filtration is required or in combination to remove heavy solids contamination. Unit restores most lubricating and industrial oils—The Hilliard Corporation

Just circle key numbers on the Reader Service card, page 101, to get complete product story



Cable cutter is powered by own hydraulic pump

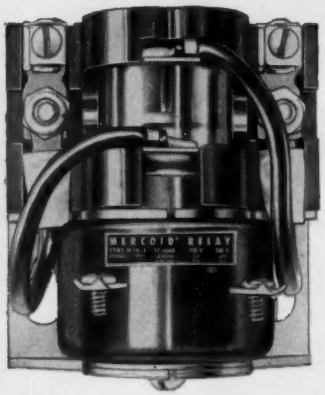
23 • Where an outside power source is not handy, utility companies may find this hand-hydraulic cable cutter useful. A fast-acting pump forces hydraulic fluid through h-p hose to ram assembly, delivering 25,000-psi to drop-forged cutting blades. Two models cut copper and aluminum commu-

35 AMP

* 120V. Non-Inductive A.C. heater loads

Plunger Type

MERCURY RELAY



by

MERCOID

If you need reliability and durability, this quality built relay by Mercoid is your answer.
For heavy duty loads, such as resistance heating, (domestic, commercial, industrial)—heat treating furnaces, drying equipment, welding, lighting, illuminated signs, score boards.
Hermetically sealed mercury to mercury contact provides visible on-off operation. Silent and chatterless. Quickly mounted, easily wired. Speeds up to 100 operations per minute.

Available normally open;

CONTACT RATING:

LOAD			*NON INDUCTIVE HEATER LOADS	
	AC	DC	AC ONLY	
120V.	30A.	15A.	120V.	35A.
240V.	20A.	10A.	240V.	25A.
440V.	8A.	—	440V.	10A.

WRITE FOR BULLETIN 0-20

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.

circle 274 on Reader Service card, p 101

circle 275 on Reader Service card, p 101 for this ad ➤

The Miracle Packing Material for Every Sealing Application

Anchor ANKLON is a superb packing made from Teflon—a smooth, waxy tetrafluoroethylene resin with excellent dielectric properties. Tough, durable and resilient, Anklon resists chemicals, oils, fuels, food products, steam and water *at temperatures to −80°F, and to +500°F.!* Anklon will keep friction to a minimum. Water absorption by the material is zero. And, Anklon is furnished in a wide variety of forms:

"V" Sets... O-Rings... Valve Discs... Flexible Couplings... Cement... "U's"-Cups-Flanges . . . Expansion Joints . . . Packings and Gaskets ... Rods... Sheets... Lantern Rings... Tapes... Tubing... Impregnated Cloths and Felts . . . Hose . . . Spray Dispersion . . . Powder . . . Faucet Washers... Thread Seal.

Get further information on this versatile packing material. See your Anchor Representative, or contact the Anchor General Office in Philadelphia.

*Made of DuPont Teflon. Not recommended for use with alkali metals, fluorine, or fluorine forming compounds

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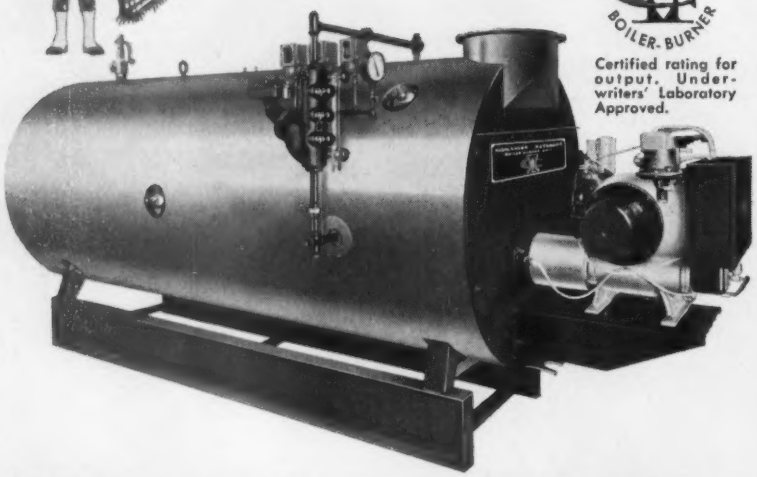
NEW HIGHLANDER

COMPLETELY AUTOMATIC BOILER-BURNER UNIT

HIGHLANDER BOILER-BURNER

Certified rating for output. Underwriters' Laboratory Approved.

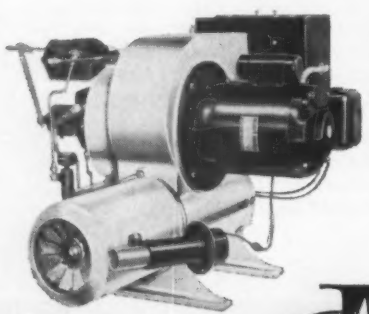


PROVEN ECONOMY

SAVES ON INSTALLATION. The new Highlander is a completely assembled boiler-burner plant. Installing one simple unit saves money. Designed by Engineers with years of experience in matching burners and boilers for the exact job—whether it is power, processing or heating. No problem of taking a boiler and trying to match a burner to it. The Highlander Boiler-Burner unit is design-controlled at the factory.

SAVES ON OPERATION. Designed to get maximum economy from available fuels. The Highlander is built for low pressure or high pressure steam or hot water — Industrial Combustion burner furnished for a heavy oil, light oil or combination of gas/light or gas/heavy oil. Simple! Just 2 flue passes. Easy Maintenance! Boiler interior easily accessible. Reliable! Each burner is completely fire tested at the factory.

YOUR CHOICE OF HEV-E-OIL, HEV-E-DUTY GAS or COMBINATION GAS and OIL BURNER



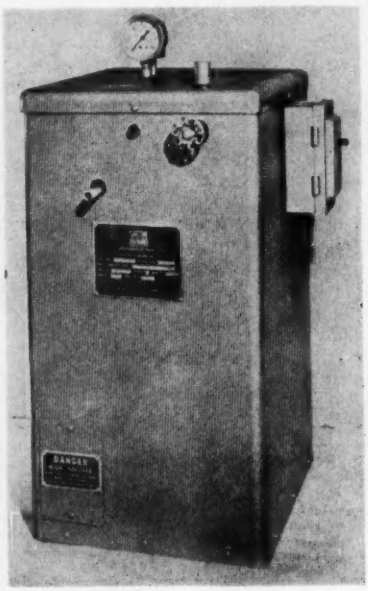
HEART OF THE HIGHLANDER is the famous Industrial Combustion Burner. The HEV-E-OIL Burner engineered to use inexpensive No. 4, 5 and 6 heavy oils is shown here. Available from 5 to 150 gph. HEV-E-DUTY Power Gas Burners and Combination gas/oil Burners from 720,000 to 21,000,000 BTU.

Write Dept. J-71 for complete information.

INDUSTRIAL COMBUSTION INC.

EXECUTIVE OFFICES: 4447 N. OAKLAND AVE., MILWAUKEE 11, WIS.

nication cable (not ACSR) up to 3-in. OD. Safety features: one man can work the pump at street level while another makes the cut underground; cutter head is compact, a bonus in tight spaces.—H K Porter, Inc



Electric steam boilers

64 • Compact, plug-in electrode steam boilers protect from low-water or dry-boiler damage. Automatic modulating control regulates electric input to balance steam output at desired preset pressure.

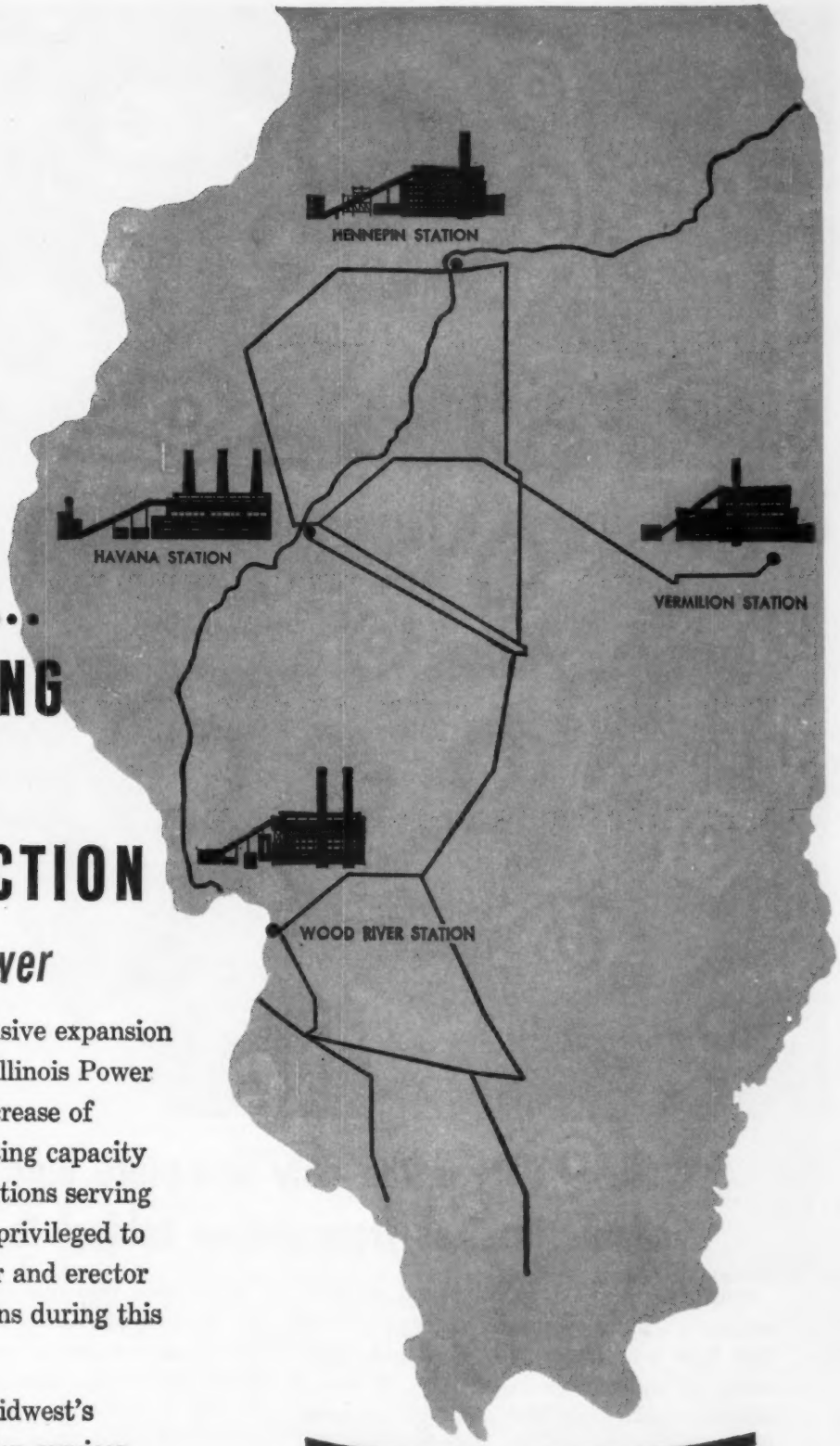
There are no pressure switches or relays with contacts to burn out—important with dust or explosive fumes or where unattended, uninterrupted service is essential. Price: $225.—Pantex Mfg Corp

Just circle key numbers on the Reader Service card, page 101, to get complete product story

Dust-collector tube replaces permanent ductwork

61 • Adjustable suction-tube assembly for unit dust collectors eliminates need for permanent ducts, manufacturer states. Tube is flexible fabric hose supported by lightweight arms which pivot to allow movement to any desired position.

Available in 3- and 4-in. hose diam-



14 YEARS... CONTINUING PIPING CONSTRUCTION

for Illinois Power

A 14-year era of extensive expansion has been enjoyed by Illinois Power Company, with an increase of 1,092,000 KW generating capacity shared by the four stations serving the state. Midwest is privileged to have been the supplier and erector of piping for all stations during this expansion program.

For information on Midwest's complete piping erection services for power stations and industrial processing plants, write today for 24-page illustrated brochure POWER AND PROCESS PIPING. 6119

MIDWEST PIPING

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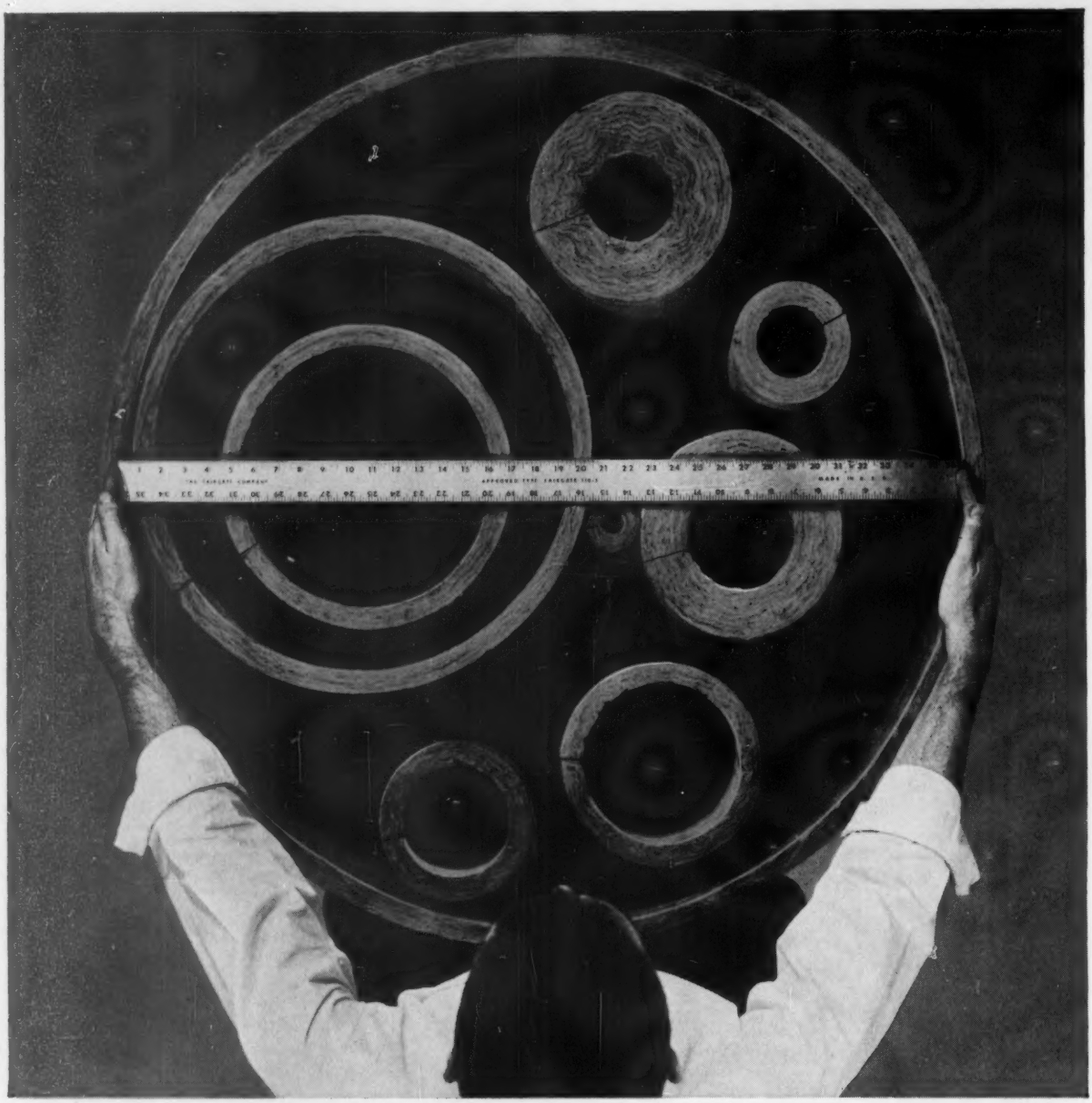

G-B SNAP*ON® is the only one-piece pipe insulation available in sizes from copper tubing to 36" IPS

Only G-B Snap*On offers you all the time-saving, cost-cutting advantages of a one-piece glass fiber pipe covering for pipe sizes from copper tubing all the way up to 36" IPS. With G-B Snap*On's snap-hinge action, you can cut installation time up to 50% on virtually every pipe insulating job—and even more on the larger pipe diameters. It's available in 3′ sections, plain or with a wide variety of factory-adhered jackets for sub-zero to 350° F. piping—indoors or out, and in 6′ sections without jackets.

More often than not, G-B Snap*On requires less thickness than other pipe coverings to provide equal or superior insulating efficiency—another feature that saves you money. Permanent as glass itself, G-B Snap*On does not rot, corrode or otherwise deteriorate. Write for complete information today.

GUSTIN-BACON Mfg. Co. GUSTIN gb® BACON

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Thermal and acoustical glass fiber insulations • Molded glass fiber pipe insulation • Couplings and fittings for plain and grooved end pipe

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Southern Metal Products Co.
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SALT LAKE CITY, Utah, Bullough Asbestos Sup. Co.
SAN ANTONIO, Tex., San Antonio Machine & Supply Co.
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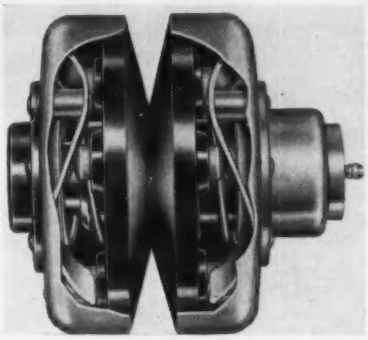
WEST PALM BEACH, Fla., Southern Metal Prod. Co.
WICHITA, Kans., Wichita Sheet Metal, Inc.
6-1-61

Equipment news

Begins on page 114

eters, assembly rotates 360 deg and has up-and-down travel of almost 8 ft. It is equipped with a fixed dust nozzle. Suction tube lets collector move—one collector can handle a number of alternately operating dust-producing machines. Tube-assembly price: $60.—Torit Mfg Co

Just circle key numbers on the Reader Service card, page 101, to get complete product story



Pulleys feature cam control

63 • Wide V-belt pulleys are rated 1 to 5 hp at 1750 rpm. They provide instantly variable ratios up to 3:1. Each pulley face is independently actuated by its own spring and cam assemblies. Opposite wedging action of each cam and cam follower prevents pulley spread — assuring constant speed at all times, even with overload. Cam action keeps belt constantly in alignment and never under excess tension.

Springs are not driving members—they serve only to keep pulley faces in contact with belt for smooth and steady transmission of power. Assemblies are designed to prevent spring pressure and assure longer belt life.—Hi-Lo Mfg Co

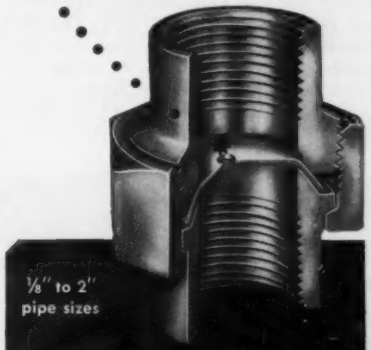
Reliable annunciator has no moving parts

36 • All-transistor annunciator has no moving parts and no relay contacts to pit or corrode. It operates when a set of remote contacts opens or closes. Indication area measures 2 x 3 in.—Radiation Technology, Inc

here's real **ECONOMY...**
time-saving **SIMPLICITY...**
and sure-fire **DEPENDABILITY**

for metering, measuring, controlling any piped material!

this Catawissa Cup-Orifice Plate CONVERTS any standard Catawissa Union into a ***GASKETLESS*** **ORIFICE UNION**



ELIMINATES the necessity of expensive gaskets...the uncertainty of what type gaskets are needed for specific temperature and pressure requirements... fumbling with extra parts!!!

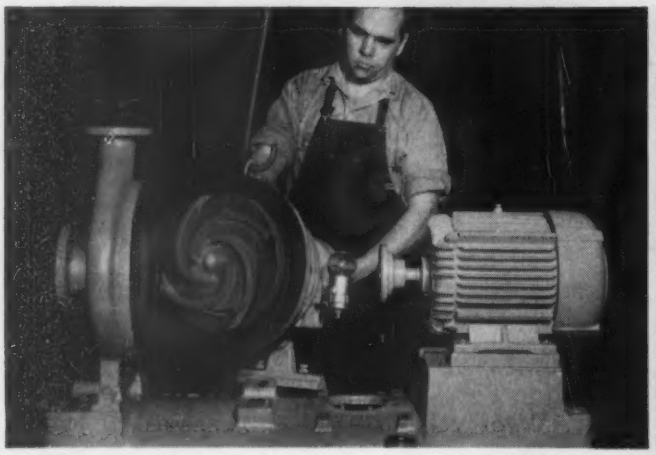
Orifice Union problems of the past are gone forever! Stainless or carbon steel cup-orifice plate fits easily, quickly, securely to form a good, tight, leakproof seal. Temperature and pressure requirements are restricted only by the rating of the union itself (3000-lb. service, 9000-lb. test)!

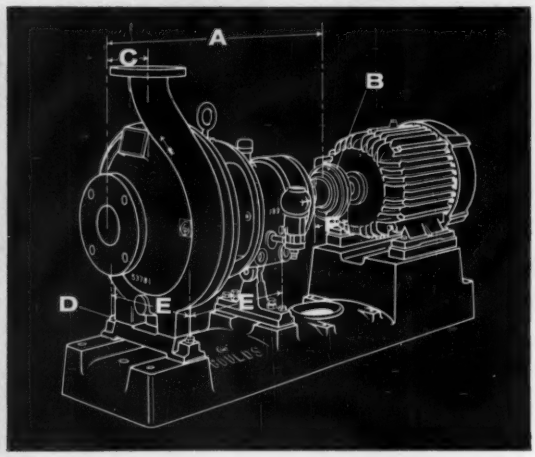
Just specify "Catawissa Cup-Orifice Plates" or "Catawissa Cup-Orifice Unions" at your favorite supply store—or write for catalog and complete information.

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA
circle 279 on Reader Service card, p 101

PUMPAGE

Goulds news about pumps for process industries





Standardized design features

Model 3195 gives you the greatest range of coverage and flexibility—with minimum parts needed—of any design on the market.

To meet varying service conditions, you can mount any one of the 11 pump ends to any one of three bearing frames (shafts 1¼, 1¾, and 2⅛ through stuffing box). Nominal impeller diameters of 6″, 8″, and 11″ cover the range. Capacities to 775 G.P.H., heads to 300 ft. TDH. Handles liquids up to 500°F.

Dimensional interchangeability between all Model 3195 pumps

With this top-centerline, broad-coverage design, you can interchange pumps without making expensive piping changes. It has

A	One over-all length in all sizes	23″
B	One coupling fit for all sizes	1⅛″
C	One dimension end from suction to centerline of discharge	4″
D	One bolt size for holding pumps to bases	½″
E	One bolt spacing for holding all pumps to bases	
F	One spacer coupling length for all sizes	3½″

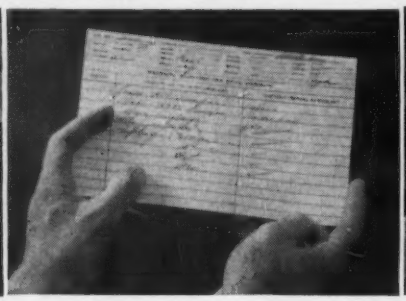
Back pull-out design lets you easily replace parts most subject to wear without disturbing pipe connections or motor mountings. For full information, write for Bulletin 725.1.

How to dewater a flood

Deep in a Virginia mine, water that could fast become a flood is being pumped out at as much as 8000 gpm for New Jersey Zinc Company.

More than a generation of miners has grown up since the first of the pumps started working. Yet these pumps, as well as the newer ones, perform so dependably that four more are slated to join them.

All 30 are Goulds single-stage, double-suction centrifugals. All use mechanical seals. All are grease lubricated.

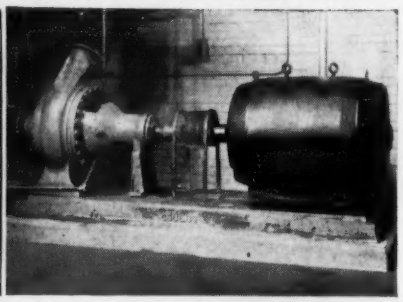


Easy way to diagnose pump failure

Keep complete maintenance records on easy-to-use cards. Failures show chronologically, making it easier to get at the root of the trouble.

Cards are a help in ordering new parts, scheduling lubrication, and in determining pump suitability for new requirements due to process change.

Like a free supply of these pump maintenance record cards? Drop us a line. For information on this, or other products on this page, write Goulds Pumps, Inc., Dept. PO-71, Seneca Falls, N.Y.



Unique-alloy pump fights abrasives

The first pump in the system at Bestwall Gypsum Company's Pryor Mill works on a particularly tough service. It must handle bits of metal and glass the junk remover doesn't get.

It's a Goulds Model 3139 constructed of ISO-40.* This stainless steel alloy, highly resistant to corrosion and abrasion, has BHN hardness of 320 and tensile strength of 140,000 psi.

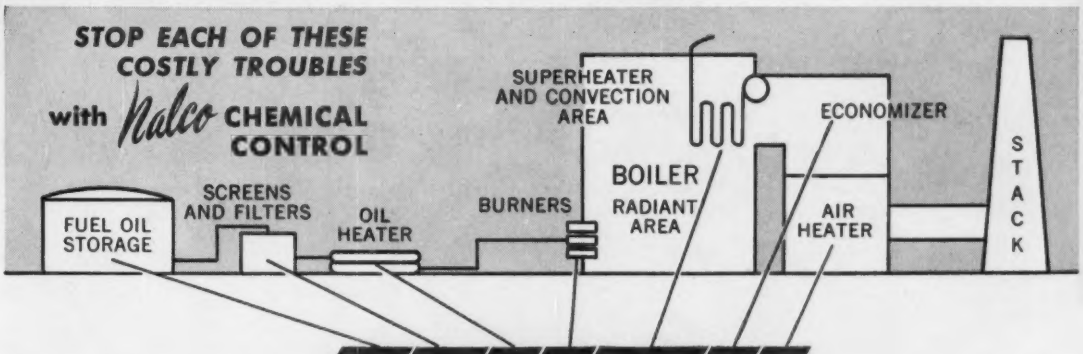
Do you have a similar severe application problem? Let us know. ISO-40 is available in several of our designs.

*Registered trademark of Empire Steel Castings, Inc.

GOULDS PUMPS

For more facts circle 280 on Reader Service card, p 101

Nalco Residual Fuel Oil Treatments Protect Boiler Systems from Storage to Stack



COMBUSTION PROBLEM	STORAGE TANK & LINES	SCREENS AND FILTERS	HEATERS	BURNERS	FURNACE AND CONVECTION SECTION	ECONOMIZER	AIR HEATER	Nalco COMBUSTION TREATMENT
Sludge Settling	X		X					Dispersant
Corrosion	X							Corrosion Inhibitor
Sludge, Varnish and Emulsion Formation	X	X	X	X				Stabilizer
Cleaning (Heavy sludge & deposits)	X							Solvent and Dispersant
Soot					X			Combustion Catalyst
Slag					X			Inhibitor for SO_2 to SO_3 Reaction and High Melting Point Materials
Low Temperature Deposits and Corrosion						X	X	Inhibitor for SO_2 to SO_3 Reaction and Neutralizing Materials

Low-cost fuel oil will not become an expensive cause of power plant maintenance and replacement costs when you put Nalco treatments to work controlling sludge, deposits, corrosion, soot, slag or acid formation. There is a Nalco treatment for each of these specialized jobs . . . to provide you with effective protection from storage to stack.

Pre-Flame System

Storage tanks and the pre-flame fuel system can be kept deposit- and corrosion-free with Nalco sludge dispersants, corrosion inhibitors and stabilizing treatments. Where sludge deposits have built up in tanks, there are Nalco treatments that will disperse them into usable fuel and recover lost storage space. Stabilizers and dispersants assure better burning by preventing fouling of burners by varnish or sludge.

Furnace and Convection Area

Soot and slag deposits are common troubles caused by untreated residual fuel oils. There is a Nalco treatment for control of each of them . . . to substantially boost efficiency and reduce mechanical cleaning costs. Combustion catalyst type treatments lower soot ignition temperatures . . . assure more complete combustion, cleaner burning. Slag deposits are substantially reduced by additives that modify the high temperature chemical reactions of ash and sulfur in the oil.

Economizer and Air Heater Sections

Keeping corrosion and acidic deposits out of economizers and air heaters was often the most difficult part of plant combustion problems to solve economically—until Nalco developed successful "cold-end" treatments. Inhibitor-neutralizers modify the chemical reactions which convert sulfur dioxide to the sulfur trioxide that creates corrosive conditions in low temperature areas.

Long Range Economy

Residual fuel oils, *plus Nalco fuel oil treatments*, can build a very attractive operating-cost picture in your plant. For a flying start toward long-range fuel economy, call your Nalco Representative today, or write us for details on *specific* Nalco answers to your combustion problems.

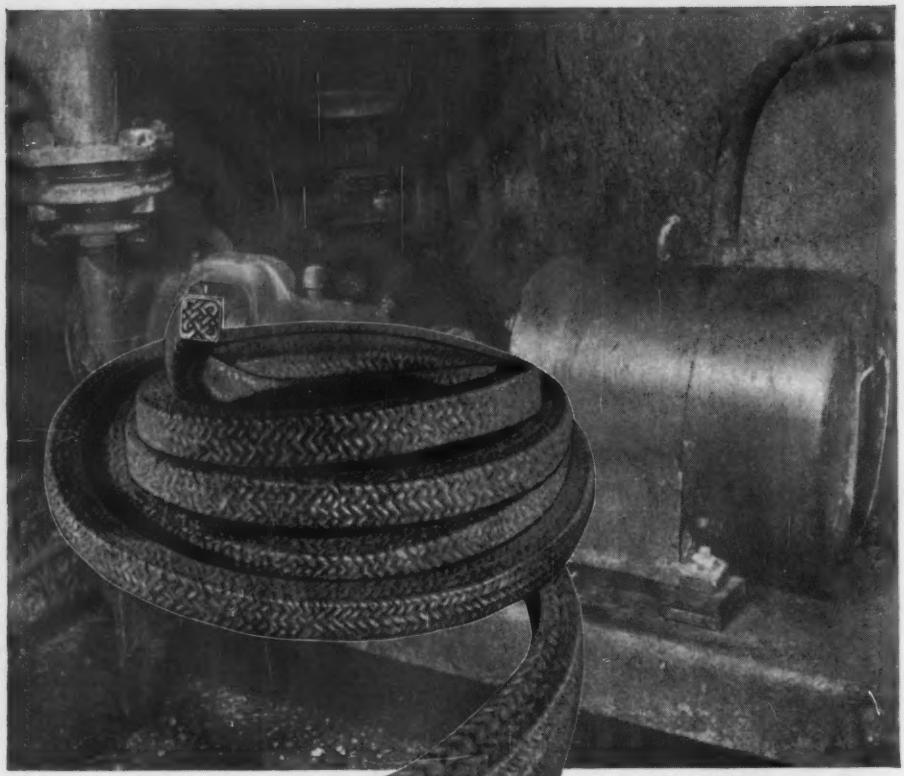
NALCO CHEMICAL COMPANY
6222 West 66th Place • Chicago 38, Illinois
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada—Alchem Limited, Burlington, Ontario

Nalco® ... Serving Industry through Practical Applied Science

Nalco CHEMICALS Nalco SERVICES

For more facts circle 281 on Reader Service card, p 101

Apply Garlock 5875 Teflon-impregnated LATTICE BRAID Packings to centrifugal and rotary pump shafts, valve stems and expansion joints, and reciprocating rods, rams, and plungers . . . a premium packing at regular packing prices.**



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Exclusive Garlock manufacturing technique creates unique properties in Teflon-impregnated LATTICE BRAID Packings. The use of pre-sintered Teflon gives new, low cost Garlock 5875 LATTICE BRAID†Packing greater stability under temperature changes and outstanding resistance to glazing. The pre-sintered Teflon on the white asbestos yarn does not absorb water; hence, there is no "wicking" action, and minimum axial swell. The ground particles of Teflon form millions of bearing points on the packing surface . . . effectively reduce friction and wear . . . once installed, retightening or adjustments are rarely, if ever, necessary. Garlock 5875 LATTICE BRAID Packing contains over 30% Teflon by actual weight—affords excellent resistance to moderately destructive and corrosive acids and caustics from −90°F to +500°F.

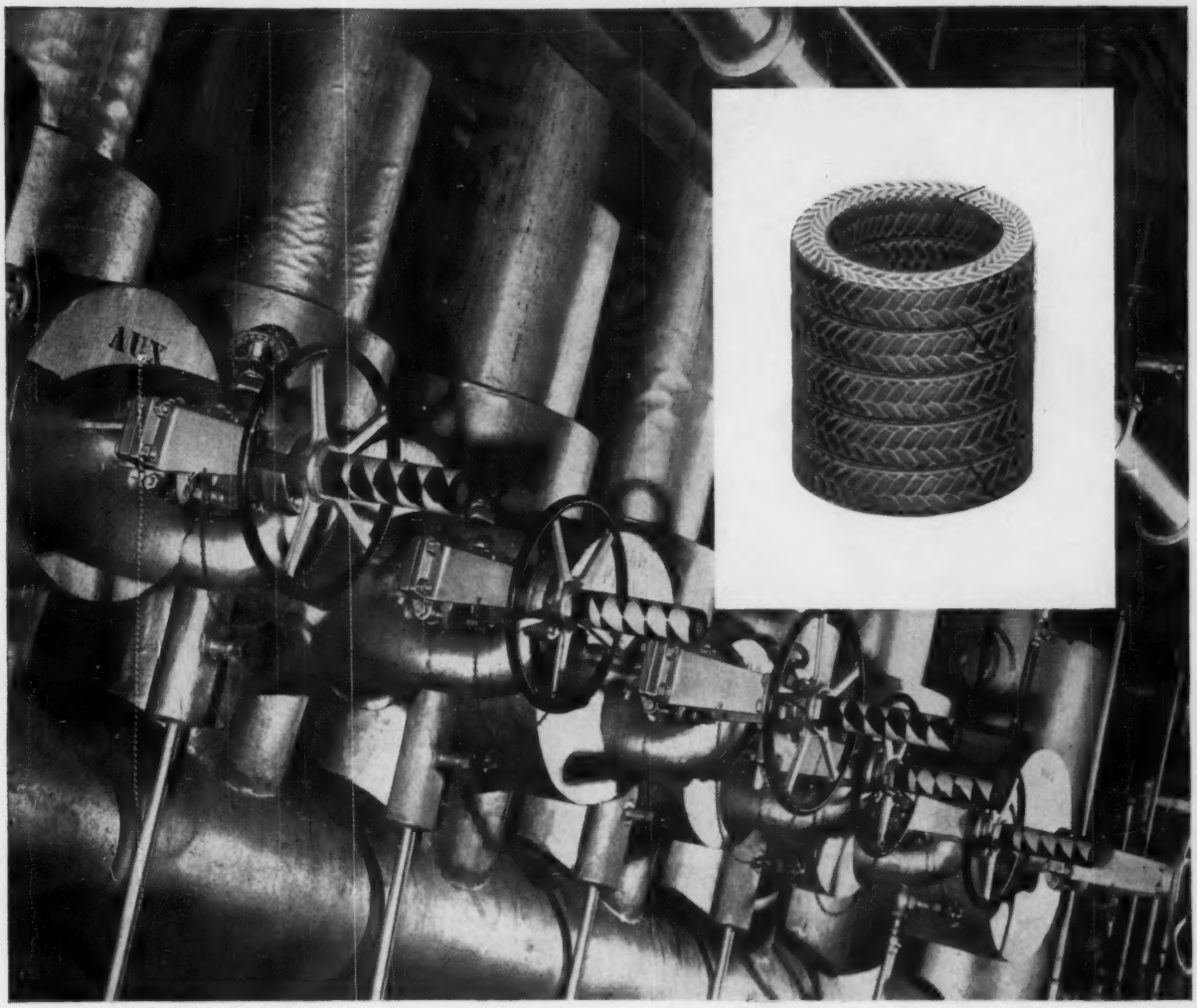
Costs no more than regular packing. Garlock 5875 LATTICE BRAID Packing sells for almost 40% less than other Teflon packings in use today. At this price, you can enjoy all the new features of 5875 plus the advantages of LATTICE BRAID construction: completely integrated structure for greater strength, longer life, more flexibility and lower maintenance cost. No single outer braid or cover to wear through. Garlock 5875 LATTICE BRAID holds together without disintegrating, wears far beyond ordinary packings.

Enjoy fast delivery from warehouse stock. Garlock 5875 Packing is immediately available in sizes from ¼" through 1" in either spool or reel form to meet your specific needs; also available on order in ring form. Call your local Garlock representative at the nearest of the 26 Garlock sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-185, Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd. **Plastics Div.:** United States Gasket Company. **Order from the complete line** of quality Garlock products . . . Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts.

*DuPont Trademark for TFE Fluorocarbon Resin †Registered Trademark

GARLOCK



Packings of asbestos and TEFLON® TFE in 7 steam valves stopped leakage...reduced maintenance...saved $280 per year

The packings: asbestos impregnated with a Du Pont TEFLON TFE-fluorocarbon resin. The application: main distribution control valves on the boiler header shown above, handling steam at 150 psi and 356°F. The performance advantages: packings do not leak . . . do not need retightening . . . last indefinitely . . . valves turn easily without "persuaders". Unlike oil, grease and graphite additives, which squeeze out and leave a dry, abrasive base, the impregnations of TEFLON make a lasting mechanical bond with the asbestos. The cost savings: average savings per valve of $10 a year on repacking and retightening formerly necessary, and $30 per year formerly lost through leaking steam—a total saving of $280 per year for the 7 valves.

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These facts have been put to the hard test of dollars-and-cents cost accounting in many hundreds of applications. In addition to reduced costs of packing maintenance and replacement, the use of TEFLON permits standardization, cuts down inventories of many different types of packing. Consult your supplier about the many varieties of constructions available in packings made with TEFLON and write for new booklets: "Packings for Valves and Pumps" and "Designing with TEFLON". Address: E. I. du Pont de Nemours & Co. (Inc.), Dept. P-7, Room 2507T, Nemours Building, Wilmington 98, Delaware.

In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

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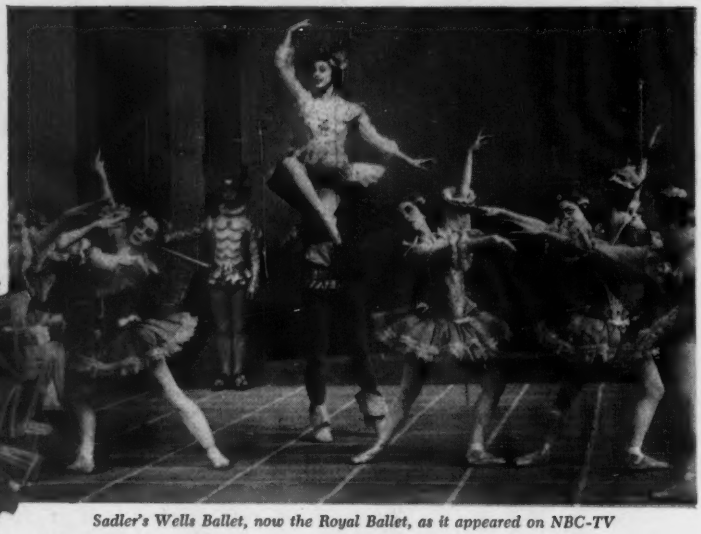

Sadler's Wells Ballet, now the Royal Ballet, as it appeared on NBC-TV

Ballerinas know, as do women everywhere, that confidence is difficult to measure. For, it often rests on little things—from a dab of makeup to the dependability of a zipper. Engineers know it too... knowledge acquired from years of strict attention to detail. Typical is the confidence of Talon engineers, men who build amazing dependability into every Talon fastener.

Talon, Inc. engineers have chosen Sel-Rex Selenium Rectifiers and Sel-Rex Remote Control Units to supply and to control the D.C. needed in their metal finishing departments. These Sel-Rex units provide the power for nickel plating, copper plating and zinc barrel plating —where superior quality depends upon precise current and its control.

According to Robert E. Hammer, Manager Plant 7, Talon, Inc., Meadville, Pa., "We rely on these units not only for minimum maintenance requirements but also for the exacting power control necessary to maintain our high quality standards."

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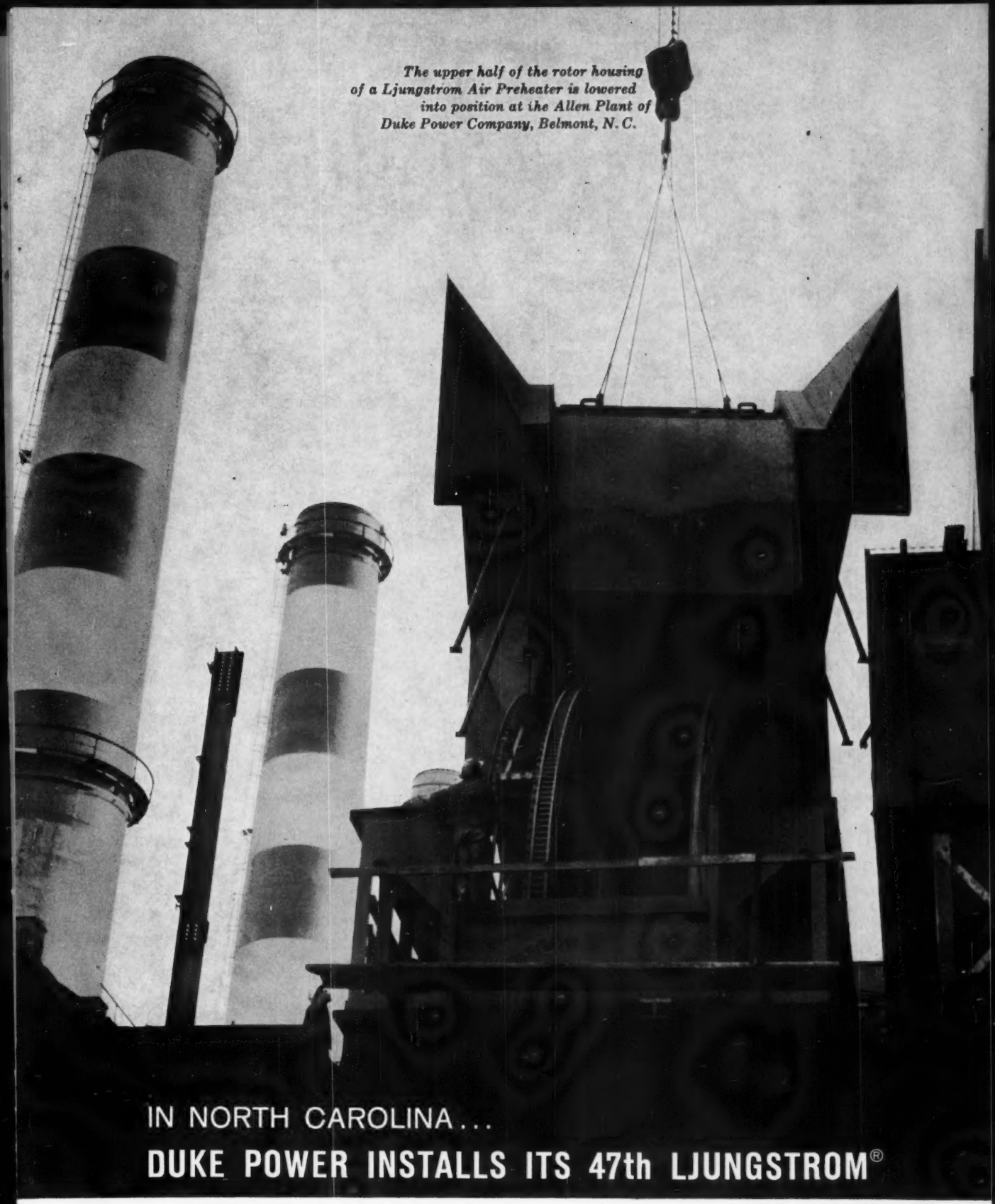

The upper half of the rotor housing of a Ljungstrom Air Preheater is lowered into position at the Allen Plant of Duke Power Company, Belmont, N. C.

IN NORTH CAROLINA . . .

DUKE POWER INSTALLS ITS 47th LJUNGSTROM®

Duke Power engineers expect 10% annual fuel cost savings with Ljungstrom Air Preheaters at Belmont. Two 512,000-lb Ljungstroms on the #5 boiler of the Allen Plant will preheat incoming air from 80°F to 575°F. Continuous rotary regeneration will recover approximately 390°F waste heat. Every 40° thus recovered cuts fuel requirements 1%.

Our engineers will be glad to recommend how Air Preheater equipment can improve your operating results on new or existing fuel fired units.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N.Y.

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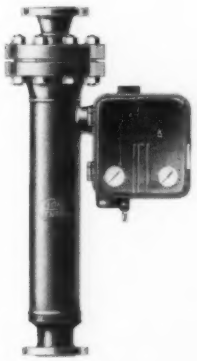
*

Little more than a speck in the Gulf of Mexico, a separator platform must hold all the equipment necessary to serve a number of producing wells. There just isn't room for extensive stock of replacements. It takes a launch at least 5½ hours to make a 60-mile trip; a helicopter at least 45 minutes. Under these conditions controls have to stand up day after day and week after week. That's why Fisher Level-Trols are chosen for offshore operations as well as for liquid level control applications throughout the world.

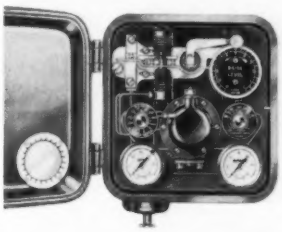
FISHER LEVEL-TROLS®

for accurate, trouble-free liquid level control on a wide range of applications....

THREE BASIC CONTROLLERS



THE POPULAR TYPE 2500 PROPORTIONAL CONTROLLER—This compact and economical liquid level controller provides a proportional band adjustment up to 100%. It is pneumatically operated and level position is manually adjustable for quick, simple selection of set point. The 2500 is suitable for 3 to 15 psi or 6 to 30 psi output ranges. Controller action easily reversed in the field. Available in all styles of mountings and housings and in displacer lengths 14″ through 120″.



TYPE 2502 PROPORTIONAL RESET CONTROLLER—This Level-Trol includes, in the same size case, all the features of the Type 2500, plus reset action. It, therefore, brings the set point back, automatically to its original position and assures absolutely stable control. Proportional band adjustable to 200% and reset rate is adjustable from .005 to 1 minute per repeat.

TYPE 2300 ELECTRONIC CONTROLLER—Explosion-proof design for hazardous locations. External adjustments for proportional band (10 to 100%) and liquid level set point. Mounts on standard Level-Trol housings. Available for output DC signals 1 to 5 ma, 4 to 20 ma or 10 to 50 ma. Has plug-in converter with printed circuit. For more information on Fisher Level-Trols write to:

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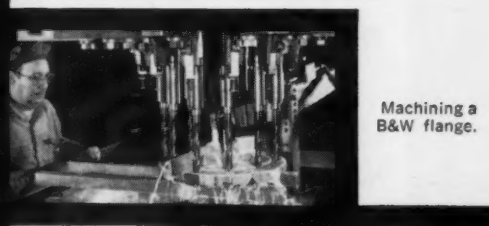
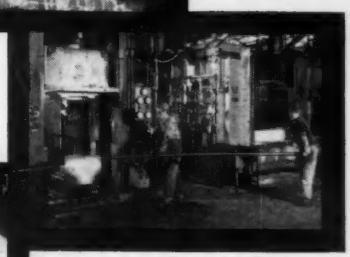
The Source for Better Service . . . a Better Product

B&W's New Fittings Plant is in FULL OPERATION

One of the mill stock bays.

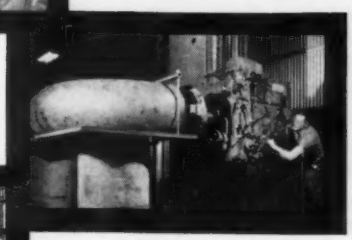


Machining a B&W flange.



Forging a tee.

Packing fittings for shipment.



Machining a 24" elbow

The paint line.

The transfer of B&W's welding fittings operations from Milwaukee to Beaver Falls is now complete. In full operation is the newest, most modern source for welding fittings and flanges in the industry. In full operation is a welding fittings plant that is integrated with B&W's facilities for steel and tube-making.

In terms of practical benefits to you, this means:

- You can get a complete line of welding fittings and flanges, quality controlled at every step of the production process from melt to the finished product.
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For further details on how B&W's new fittings plant with its integrated facilities and services can help you, contact any of the local B&W District Sales Offices or write The Babcock & Wilcox Company, Tubular Products Division, Welding Fittings Plant, P.O. Box 230, Beaver Falls, Pennsylvania.

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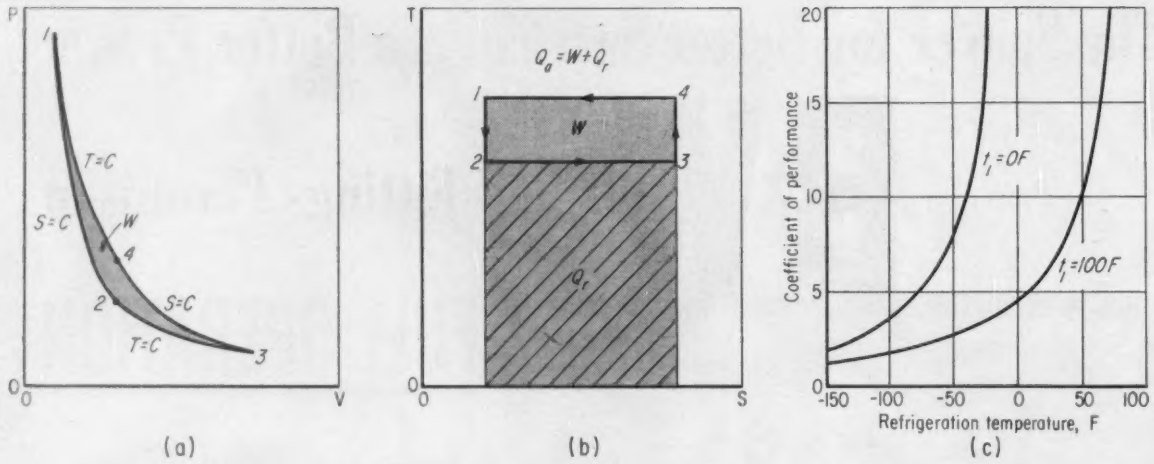


1 Carnot cycle is our ideal refrigeration machine as well as ideal power producer. (a) P-V chart relates constant temperature and entropy processes. (b) T-S chart shows heat removed Q_r and work input. (c) COP rises with refrigeration temperature

THERMO REFRESHER NO. 51

By B G A SKROTZKI, Associate Editor

Much of our good living centers around refrigeration, which means keeping specific areas at controlled temperature levels below atmospheric. And this can be done by . . .

Vapor-compression refrigerating cycles

We talked about refrigerating cycles in Part 11, Aug 1957, and Part 16, Feb 1958. It will pay us to briefly review the basics of refrigeration before studying the widely used vapor cycles.

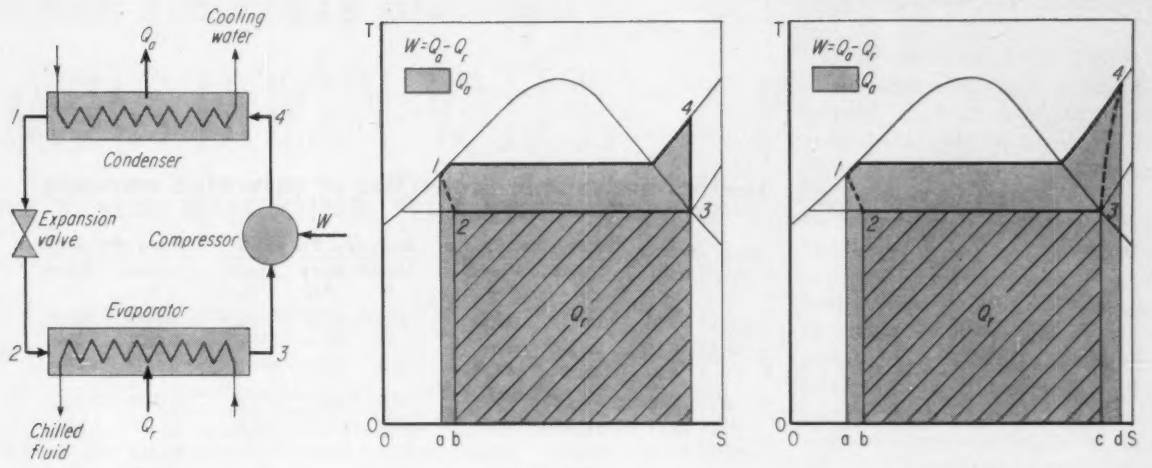
Reversed Carnot cycle. Our ideal Carnot engine becomes a refrigerating machine when we reverse the order of its processes. A refrigerating cycle's purpose is to produce a fluid with a temperature lower than that of the space to be cooled. This induces a flow of internal energy or heat transfer from the cooled space to the refrigerating fluid. Next, the fluid is compressed by work input to raise its temperature above that of the atmosphere and let fluid's heat transfer to the air. Then the fluid's temperature is reduced by making it do mechanical work, and it is ready to receive more heat from the lower level.

Fig. 1*a* shows the P-V chart and 1*b* the T-S chart for a Carnot refrigerator. At state *1*, the working (refrigerating) fluid is at the upper temperature level of the cycle. It expands at constant entropy by doing mechanical work on the piston to state *2*; this drops its temperature to the lower level of the cycle. From *2* to *3* the fluid expands at constant temperature, doing work on the piston and absorbing heat from the fluid or space being cooled.

From *3* to *4* the piston works on the fluid, raising its temperature and pressure by a constant-entropy compression. In the last process, from *4* to *1*, the piston does more work on the fluid by a constant-temperature compression that rejects heat to the atmosphere.

Ideally, heat transfers *2-3* and *4-1* would be reversible,—that is, there would be zero temperature difference between the two fluids involved. Actually, T_1 is 10 F or more higher than atmospheric temperature and T_2 is 10 F or more lower than the cooled space or fluid.

The net area in Fig. 1*a* measures work input, in ft-lb per lb of fluid, needed to make the Carnot refrigerating machine transport internal energy from the lower to the higher temperature level. The net area *1-2-3-4* in Fig. 1*b* also measures net work input W, but this time in Btu per lb of fluid.



2 (a) Vapor refrigeration cycle uses a compressor, expansion valve and two heat exchangers. (b) Ideal refrigerating cycle has compressor working at constant entropy. (c) Actual cooling cycle has compressor working irreversibly at increasing entropy

The lower hatched area measures Q_r, the heat removed from the refrigerated or cooled space, in Btu per lb of fluid. Total gray area measures the heat rejected to atmosphere Q_a, in Btu per lb of fluid.

Performance. We measure refrigerating-cycle performance by the ratio of energy output to input, but instead of being called an efficiency, it is named the "coefficient of performance" (COP). The useful output is the heat removed from the low-temperature level. The COP is always greater than one. For the Carnot refrigerator in Fig. 2*b* we have:

$$COP = \frac{\textit{energy output}}{\textit{energy input}} = \frac{Q_r}{W}$$

$$= \frac{Q_r}{Q_a - Q_r}$$

$$= \frac{T_r(S_3 - S_2)}{T_a(S_4 - S_1) - T_r(S_3 - S_2)}$$

Since $S_3 - S_2 = S_4 - S_1$

$$COP = \frac{T_r}{T_a - T_r} \qquad (1)$$

Remember, temperatures are absolute. Fig. 1*c* shows the variation in ideal COP of equation (1) for two atmospheric temperatures: T_a = 0 F (460 °R) and 100 F (560 °R). The curves show that the smaller the temperature difference T_a–T_r, the higher the COP; that is, the greater the units of refrigeration realized per unit of work input. To maintain a very-low-temperature region we have to expend a lot of mechanical work, or available energy.

Rating. A refrigerating system is rated by *tons of refrigeration*—a ton is defined as the energy that must be removed from a ton of saturated water at 32 F to freeze it to saturated ice at 32 F. While the actual enthalpy of fusion is 143.35 Btu per lb, the definition rounds this out to 144 Btu per lb so that a *ton of refrigeration* is equal to 144 × 2000 = 288,000 Btu.

Capacity of a refrigerating system is the uniform rate of heat removal, specified as a *standard commercial ton*—the number of tons of refrigeration removed in 24 hours. Equivalent expressions for the standard commercial ton of refrigeration are:

$$\frac{288{,}000}{24} = 12{,}000 \text{ Btu per hr}$$

$$\frac{288{,}000}{24 \times 60} = 200 \text{ Btu per min}$$

Another practical measure of refrigerating performance of a cycle is the horsepower input per ton of refrigeration. This comes from:

$$COP = \frac{\textit{refrigeration per hour}}{\textit{work input per hour}}$$

$$= \frac{12{,}000\,N}{2544\,Hp} \qquad (2)$$

where N = number of standard commercial tons of refrigeration and Hp = horsepower input; then:

$$\frac{2544\,Hp}{12{,}000\,N} = \frac{1}{COP}$$

$$\frac{Hp}{N} = \frac{12{,}000}{2544 \times COP} = \frac{4.72}{COP} \qquad (3)$$

Vapor cycle. Fig. 2*a* shows the flow diagram for a steady-flow vapor-compression cycle of a refrigerating system; Fig. 2*b* gives a corresponding ideal T-S chart.

Here a refrigerating fluid like ammonia (NH_3) leaves the condenser as a liquid (usually slightly supercooled) in state *1*, at the upper pressure level of the cycle. From *1* to *2* the pressurized liquid flows through an expansion or throttling valve to the lower pressure of the cycle.

During the expansion a small part of the liquid vaporizes as shown by throttling process on the T-S chart. More importantly, the temperature drops to the refrigerating level. Note that the vapor acts differently from a gas, which changes very little in temperature when throttled. The air-cycle refrigerator must make the expanding air do work to drop its temperature (see Part 16, Feb 1958).

In a liquid, however, the molecules are close together as they move past each other at different speeds (Maxwell velocity distribution). When the liquid flows into a lower-pressure space through a narrow opening

(throttle), the faster molecules have a chance to escape from their slower-moving neighbors to form a vapor. But in doing so they must work against the mutual forces of attraction between all the molecules, and so are slowed to a lower speed. Also, at the lower pressure, all the liquid molecules move slightly farther from each other, so they all work against the restraining forces of mutual attraction. This slows them down, too, and changes part of the molecular kinetic energy to potential energy. Decrease in kinetic energy shows as a lower temperature (Part 6, Feb '57).

In a gas, on the other hand, the molecules are relatively far apart to begin with. So the additional separation after throttling does little to slow them down and drop the temperature. Only by making them impact a moving piston and do mechanical work can the molecules be slowed down.

Returning to Fig. 2*a* and *b*: after expansion at *2* the refrigerating fluid is a saturated liquid with entrained bubbles of saturated vapor at the lower temperature T_2. Fluid enters the evaporator to absorb heat Q_r from the fluid being chilled. Ideally, the refrigerating fluid is boiled off to a saturated vapor state at *3*, which means that Q_r is absorbed at constant temperature $T_2 = T_3$.

The saturated vapor then enters the compressor to be pressurized and superheated to state *4* at constant entropy. The superheated vapor next flows into the condenser where it is desuperheated, condensed and slightly supercooled at constant pressure to state *1* while giving up heat Q_a to the cooling water. The cycle then repeats.

As in the Carnot refrigerator, there are only three points of energy transition in and out of the cycle. They can be related by $Q_a = W + Q_r$ or, transposing, $W = Q_a - Q_r$. Since Q_a is measured by the total gray area in Fig. 2*b* and Q_r lies wholly within area Q_a, work input is the difference between the two areas; area *a-b-2-3-4-1-a*.

For this cycle we find:

$$COP = \frac{Q_r}{W} = \frac{H_3 - H_2}{H_4 - H_3} \qquad (4)$$

We can also figure this as:

$$COP = \frac{Q_r}{Q_a - Q_r}$$

continued

1—Thermodynamic properties of saturated ammonia*

Temp, F t	Press, psia p	Volume, cu ft per lb: Liquid v_f	Volume, cu ft per lb: Vapor v_g	Enthalpy, Btu per lb: Liquid h_f	Enthalpy, Btu per lb: Evap h_{fg}	Enthalpy, Btu per lb: Vapor h_g	Entropy, Btu per lb, F: Liquid s_f	Entropy, Btu per lb, F: Vapor s_g
–60	5.55	0.0227	44.73	–21.2	610.8	589.6	–0.0517	1.4769
–40	10.41	0.0232	24.86	0.0	597.6	597.6	0.0000	1.4242
–20	18.30	0.0237	14.68	21.4	583.6	605.0	0.0497	1.3774
0	30.42	0.0242	9.116	42.9	568.9	611.8	0.0975	1.3352
20	48.21	0.0247	5.910	64.7	553.1	617.8	0.1437	1.2969
40	73.32	0.0253	3.971	86.8	536.2	623.0	0.1885	1.2618
60	107.6	0.0260	2.751	109.2	518.1	627.3	0.2322	1.2294
80	153.0	0.0268	1.955	132.0	498.7	630.7	0.2749	1.1991
100	211.9	0.0272	1.419	155.2	477.8	633.0	0.3166	1.1705
120	286.4	0.0284	1.047	179.0	455.0	634.0	0.3576	1.1427

*Abstracted from Bureau of Standards *Circular No. 142*, April 16, 1923

2—Thermodynamic properties of superheated ammonia*

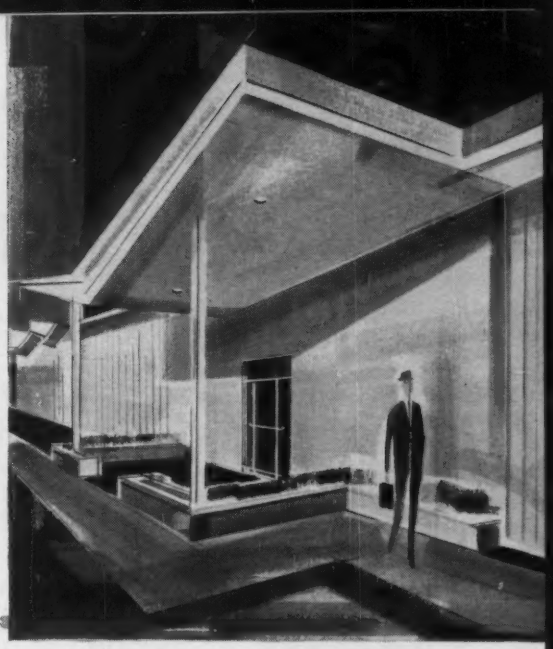
Temp, F	15 psia (–27.29-F sat) v	h	s	50 psia (21.67-F sat) v	h	s	100 psia (56.05-F sat) v	h	s
–20	18.01	606.4	1.4031	—	—	—	—	—	—
0	18.92	617.2	1.4272	—	—	—	—	—	—
20	19.82	627.8	1.4497	—	—	—	—	—	—
40	20.70	638.2	1.4709	5.988	623.4	1.3046	—	—	—
60	21.58	648.5	1.4912	6.280	641.2	1.3399	2.985	629.3	1.2409
80	22.44	658.9	1.5108	6.564	652.6	1.3613	3.149	642.6	1.2661
100	23.31	669.2	1.5296	6.843	663.7	1.3816	3.304	655.2	1.2891
120	24.17	679.6	1.5478	7.117	674.7	1.4009	3.454	667.3	1.3104
140	25.03	690.0	1.5655	7.387	685.7	1.4195	3.600	679.2	1.3305
160	25.88	700.5	1.5827	7.655	696.6	1.4374	3.743	690.8	1.3495
180	26.74	711.1	1.5995	7.921	707.5	1.4548	3.883	702.3	1.3678
200	27.59	721.7	1.6158	8.185	718.5	1.4716	4.021	713.7	1.3854
220	28.44	732.4	1.6318	8.448	729.4	1.4880	4.158	725.1	1.4024
240	—	—	—	8.710	740.5	1.5040	4.294	736.5	1.4190
260	—	—	—	8.970	751.6	1.5197	4.428	747.9	1.4350
280	—	—	—	9.230	762.7	1.5350	4.562	759.4	1.4507
300	—	—	—	9.489	774.0	1.5500	4.695	770.8	1.4660
	150 psia (78.81-F sat)			200 psia (96.34-F sat)			300 psia (123.21-F sat)		
80	2.001	631.4	1.2025	—	—	—	—	—	—
100	2.118	645.9	1.2289	1.520	635.6	1.1809	—	—	—
120	2.228	659.4	1.2526	1.612	650.9	1.2077	—	—	—
140	2.334	672.3	1.2745	1.698	665.0	1.2317	1.058	648.7	1.1632
160	2.435	684.8	1.2949	1.780	678.4	1.2537	1.123	664.7	1.1894
180	2.534	696.9	1.3142	1.859	691.3	1.2742	1.183	679.5	1.2129
200	2.631	708.9	1.3327	1.935	703.9	1.2935	1.239	693.5	1.2344
220	2.726	720.7	1.3504	2.009	716.3	1.3120	1.294	706.9	1.2546
240	2.820	732.5	1.3675	2.082	728.4	1.3296	1.346	720.0	1.2736
260	2.912	744.3	1.3840	2.154	740.5	1.3467	1.397	732.9	1.2917
280	3.004	756.0	1.4001	2.225	752.5	1.3631	1.447	745.5	1.3090
300	3.095	767.7	1.4157	2.295	764.5	1.3791	1.496	758.1	1.3257

*Abstracted from Bureau of Standards *Circular No. 142*, April 16, 1923

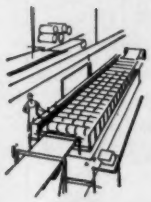
BUTLER BUILDINGS GIVE YOU

BAKER'S DOZEN VALUE

FOR YOUR BUILDING DOLLAR



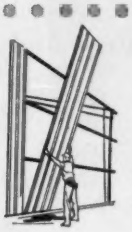
PRE-ENGINEERING. Designing a Butler building is simply a matter of selecting the correct, pre-engineered components. Routine engineering is eliminated . . . saving your engineers' and executives' time. Saving you money.



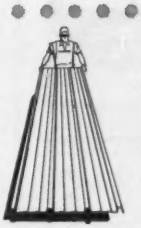
FACTORY FABRICATION. Automatic welding, shearing and gang punching are done to precise specifications—under rigid quality control. The result is a beautiful building . . . an end product that is better in every detail.

TENACIOUS FASTENERS. Experts agree, there is no such thing as a quality metal building *without* quality fasteners to keep it weathertight. That's why Butler uses costly, self-clinching rivets—machine driven to grip with 1,400 lbs. pressure.

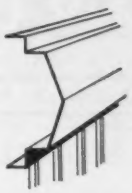
INTEGRAL ALUMINUM SASH in all three wall systems. The smooth, satiny look of maintenance-free aluminum. The smooth fit of factory-fabricated components. There's no sloppy field-cut, field-installed flashing.



SPEEDY CONSTRUCTION. Erection is so simple, Butler buildings go up weeks, even months faster. You're in your new building sooner, doing business sooner. You save time and construction cost, without sacrificing quality.



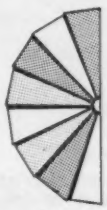
BUTLERIB® WALL PANEL. The finest single-ply wall covering made—so outstanding it is used in Butler's 20-year guaranteed roofs. It is factory color-finished outside and inside. It can be field insulated.



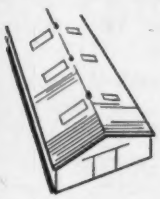
NEW TRIM. New gable and eave trim gives Butler buildings a crisp, finished look—beautiful contemporary lines. This new trim has a pleasing, two-tone finish that harmonizes with any color, any collateral material.

MORE OF YOUR WANTS, NEEDS, LIKES. There are 6 structural systems, 7 design loads, 4 bay lengths, 6 sidewall heights. You get the size building you want. And you get the type of building you want. No compromises.

BUTLER MONOPANL® A beautiful, three-ply, factory-finished, factory-insulated wall panel. Outside, bold, vertical fluting imparts strong shadow lines. Inside surface is smooth. No visible exterior fasteners. No caulking ever.



NEW BUTLER-TONE™ COLOR. Doubly desirable because it protects as it beautifies. Flat metal is galvanized, cleaned, then given a bonderizing treatment, then roll coated with a thermo setting plastic finish. 8 outside colors. Off-white inside.



TWENTY-YEAR ROOF GUARANTEE. You can have a preferred aluminum roof of such job tested superiority that Butler is now able to offer a 20-year guarantee. You're under no maintenance obligation. This guarantee is a Butler exclusive.

BUTLER MODULAR WALL. The ultimate in wall systems, yet the lowest-cost material in its field. A four-ply "sandwich" prefinished outside and in, factory insulated, too. Built-in doors and windows. Erection is simple and fast. The appearance—elegant.

FINANCING. Your Butler Builder will be glad to help you arrange financing. Ask him about the Butler Building finance plan.

Do you have any other questions? Phone your Butler Builder for the full story. He's listed in the Yellow Pages under "Buildings" or "Steel Buildings." Or write direct.

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For more facts circle 286 on Reader Service card, p 101

Boiler Tube Service

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TAMPA John D. Homan Tampa 65-7211
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ROANOKE J. J. Bower Empire 6-3474
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SAN JUAN, P.R. San Miguel & Co., Inc. Russell 1-5296
TORONTO, ONT. Ontor, Ltd.
5

BOILER TUBE COMPANY OF AMERICA

McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

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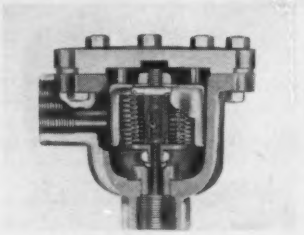
SQUIRES TM *MODULATING* STEAM TRAP

A CONDENSATE CONTROLLER SEPARATING LATENT HEAT FROM CONDENSATE & GASES

The Squires TM Trap does this:

1) *without steam loss*
2) with greatly *increased bellows life* through modulation—no on-off cycling
3) with *no cooling leg* required
4) giving accurate process temperature control through *continuous condensate removal*
5) with accellerated process temperature warm-up
6) through *latent heat sensitivity* with extremely low maintenance cost



7) giving *extremely large capacity* (⅜" orifice on 1" size), this is the lowest trap cost per pound of condensate capacity
8) 0-150 psig operation *without orifice change*

Utilizing a balanced discharge force across the seat through a unique double bellows design, the Squires Class TM Trap provides modulated, continuous flow operation and positively removes condensate and air while retaining steam with latent heat.

Send for Bulletin No. 5020

SQUIRES TYPE AD PRESSURE REDUCING VALVE

Furnished completely piped, ready to precisely control your fluid service. Bulletin No. 5890 describes positive dead-end force, wide one step reductions, sensitive control and many other cost saving features.

THE C. E. SQUIRES COMPANY

Over 50 Years of Dependability

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Begins on page 140

$$= \frac{H_3 - H_2}{(H_4 - H_1) - (H_3 - H_2)}$$

But since $H_1 = H_2$ for the throttling process, this equation reduces to the same form as equation (4).

Actual cycle. The ideal vapor cycle of Fig. 2*b* has one irreversible process *1-2*, throttling the vapor. Despite this, the T-S diagram can be used to demonstrate net work input W by the remaining unique area. An actual cycle, of course, has all irreversible processes; the compression process *3-4* will be at increasing entropy as in Fig. 2*c*.

Here we have an interesting situation again. Despite two irreversible processes, a net remaining area, *a-b-2-3-c-d-4-1-a*, measures net work input W. Comparing this to Fig. 2*b* we see the increase in work input caused by the compressor irreversibility. For the same top pressure, the actual compressor produces higher superheat of the vapor. This places greater duty on the condenser in the larger Q_a that must be transferred, even though the same refrigeration Q_r is performed.

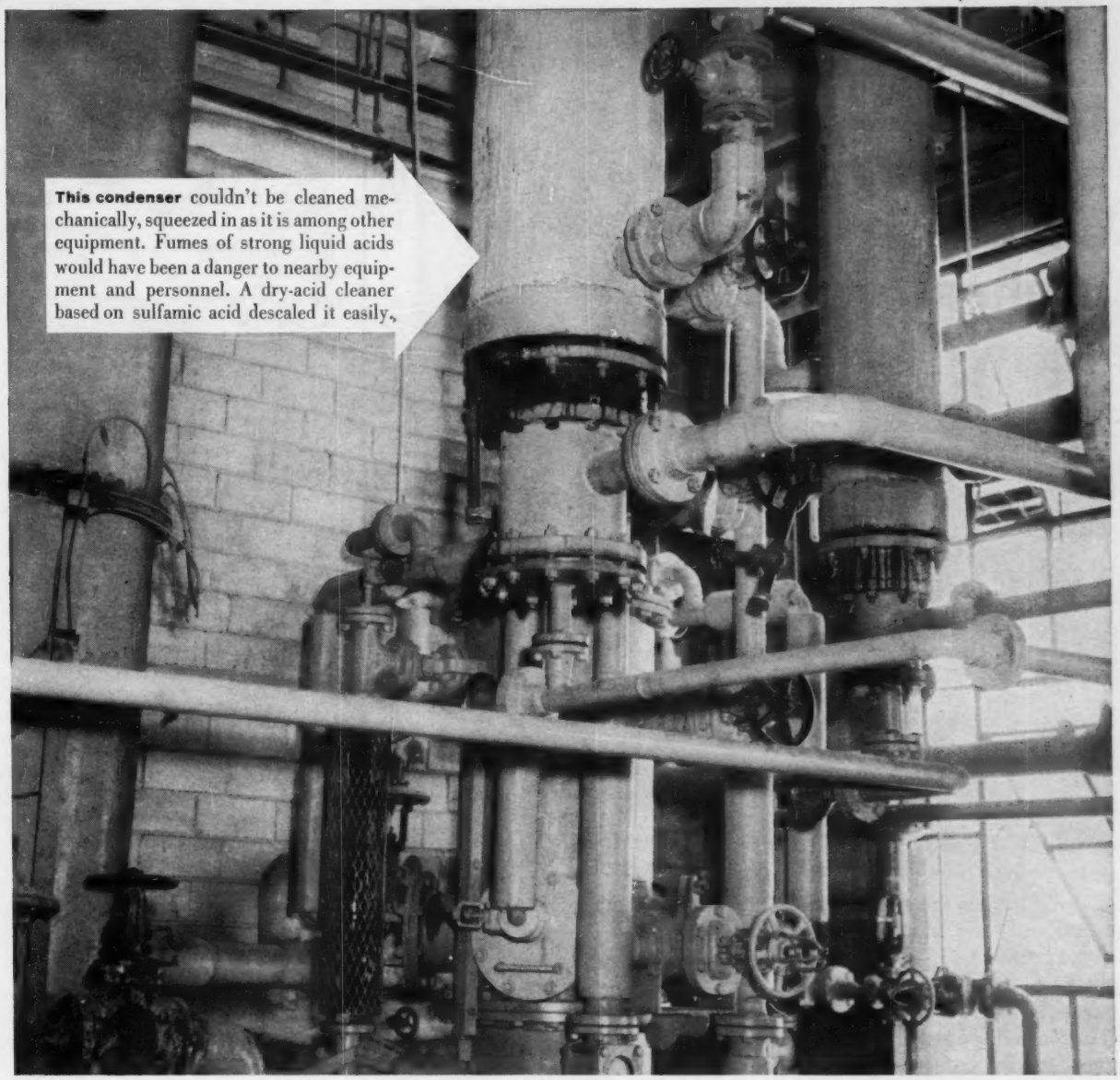
In actual cycles as well, the pressure of the fluid drops as fluid flows through the evaporator and condenser. These are not shown in Fig. 2, but note that equations (2), (3) and (4) apply to both ideal and irreversible cycles.

Refrigerating fluids obviously must stay in their liquid and vapor phases throughout the temperature range of a refrigerating cycle. The fluid must stay well above its solid phase at the low-temperature end of the cycle.

Refrigerants that are used commercially include ammonia, butane, CO_2, carrene, Freon, methyl chloride, sulfur dioxide and propane. These offer varying advantages—low temperature range, modest pressure range, heat capacity and specific volume—and these factors all affect the design and size of the cycle components.

Table 1 lists the thermodynamic properties of saturated ammonia and table 2 of superheated ammonia. Let's run through a simple refrigerating-

For more facts circle 288 on Reader Service card, p 101


This condenser couldn't be cleaned mechanically, squeezed in as it is among other equipment. Fumes of strong liquid acids would have been a danger to nearby equipment and personnel. A dry-acid cleaner based on sulfamic acid descaled it easily.

Descale equipment in place safely, easily with Dry-Acid Cleaners based on Du Pont Sulfamic Acid

Routine descaling of even the most hard-to-get-at equipment is now possible with dry-acid cleaners based on Du Pont Sulfamic Acid. You cut downtime drastically, because there's no need to dismantle or protect surrounding equipment from corrosive fumes.

Just dissolve these dry-acid cleaners in water and they're ready to remove even the most stubborn scale and deposits—often the solid granules can be added directly to the equipment. Yet dry-acid cleaners are far less corrosive to metal than hydrochloric acid. And the operation is so safe the only protective clothing needed is goggles; elaborate apparatus and specially trained personnel are unnecessary.

Dry-acid cleaners based on Du Pont Sulfamic Acid are available everywhere. If you'll mail the coupon, we'll send a list of suppliers and more information.

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BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

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Please send your "Quick Facts on Dry Cleaners" booklet and names of formulators offering cleaners based on sulfamic acid.

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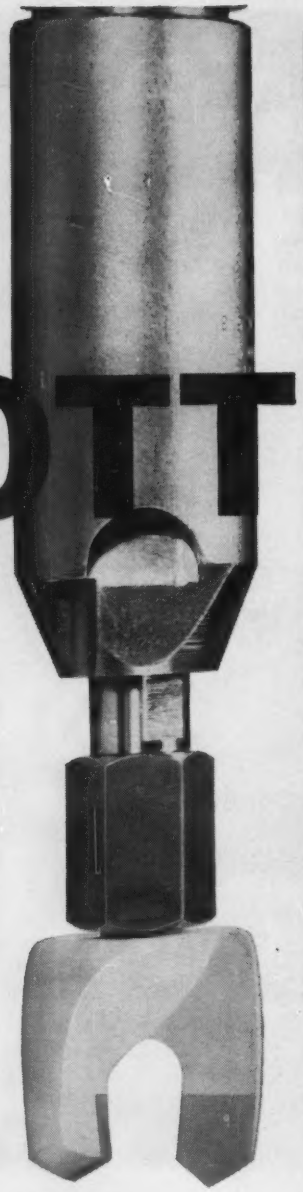
to clean badly clogged air preheater tubes

ELLIOTT

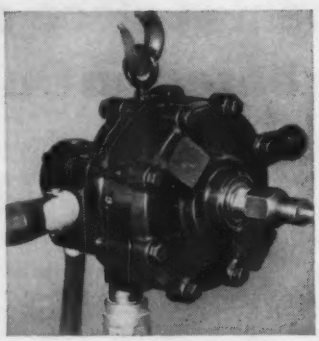
heavy duty tube cleaner



Shown above is the powerful Lagonda heavy-duty air motor with carbide-tipped cutter bit. Attached to a flexible air hose, this unit can operate in any position where headroom is limited. The carbide tip will clean even the most badly clogged tubes, quickly and effectively.

Where headroom permits, the heavy-duty suspended-type motor shown at the right can be used to drive a cutting bit attached to a hollow steel shaft, through which flushing and cooling water is fed. This extremely powerful unit can be used either vertically or horizontally.

Full information and prices may be obtained from any Elliott District Sales Office, or by writing Elliott Company, Lagonda Plant, Springfield, Ohio.



Y 1-1

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

Thermo refresher

Begins on page 140

cycle problem using ammonia as the refrigerant.

Example. For the cycle in Fig. 2*a*, ammonia leaves the evaporator as a wet vapor with 95% quality and a temperature of −20 F. The compressor raises the pressure at constant entropy to 100 psia. Ammonia leaves the condenser as a subcooled liquid at 50 F. Find (a) the heat removed by the evaporator in Btu per lb of ammonia (b) the work input to the compressor (c) heat rejected in the condenser (d) COP of the ideal cycle (e) Hp per ton of refrigeration (f) quality at state 2.

Solution: Using data from table 1 in:

$H_3 = h_f + xh_{fg}$
$= 21.4 + 0.95 \times 583.6$
$= 575.8$ Btu per lb

$S_3 = s_f + xs_{fg}$
$= 0.0497 + 0.95 \times 1.3277$
$= 1.3110$ Btu per lb, F

$S_4 = S_3 = 1.3110$ Btu per lb, F

Interpolating in the 100-psia superheat section of table 2:

$$T_4 = 130 - \frac{1.3206-1.3110}{1.3206-1.3104}(130-120)$$

$= 120.6$ F

$$H_4 = 673.3 - \frac{1.3206-1.3110}{1.3206-1.3104}(673.3-667.3)$$

$= 667.7$ Btu per lb

From table 1 at 50 F:

$H_1 = 97.9$ Btu per lb $= H_2$

(a) $Q_r = H_3 - H_2$
$= 575.8 - 97.9$
$= 477.9$ Btu per lb

(b) $W = H_4 - H_3$
$= 667.7 - 575.8$
$= 91.9$ Btu per lb

(c) $Q_a = H_4 - H_1$
$= 667.7 - 97.9$
$= 569.8$ Btu per lb

(d) COP $= Q_r/W = 477.9/91.9$
$= 5.20$

(e) Hp/N $= 4.72/5.20 = 0.908$

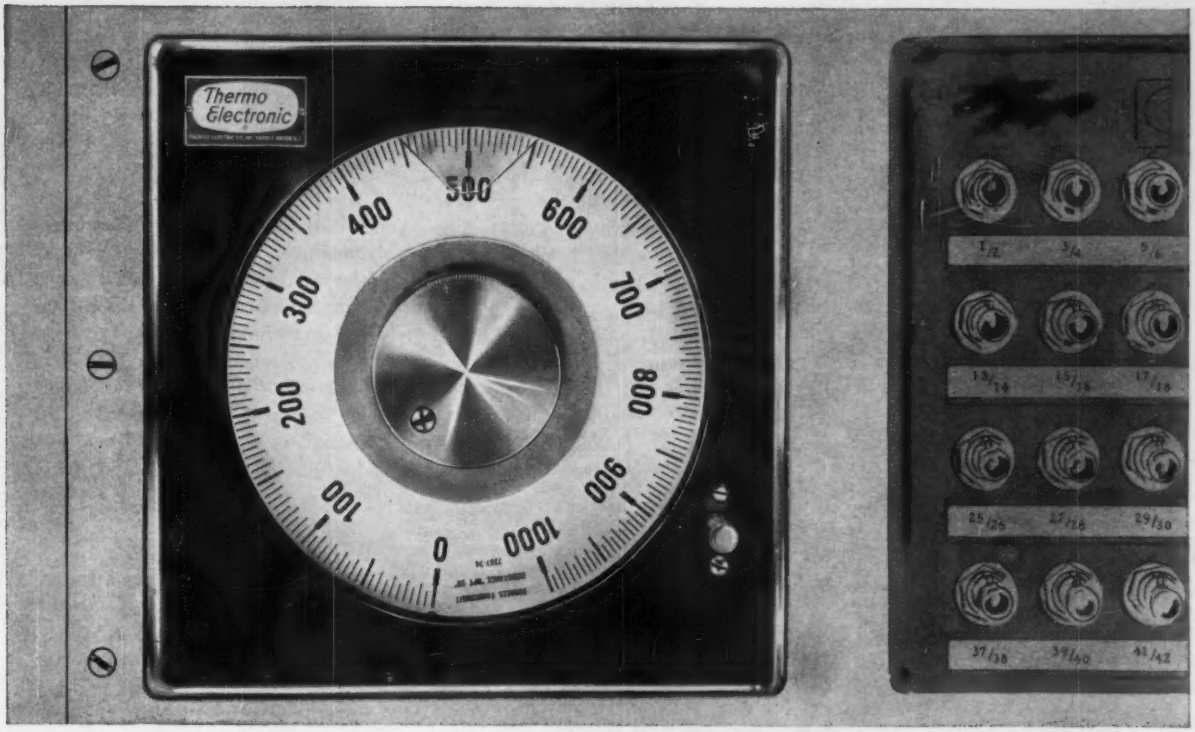
(f) From table 1 at −20 F:

$$X = \frac{H_2 - h_f}{h_{fg}} = \frac{97.9 - 21.4}{583.6}$$

$= 0.1311$ or 13.11% quality

Next part will deal with advanced vapor refrigeration cycles and vacuum refrigeration cycles.

do You need this Thermo Electronic Self-Balancing Indicator...?



You do if you need...

Compactness – Requires just a 7½" square of your panel space, yet has long, legible 16" dial.

Versatility – Bridge or Potentiometer type temperature measuring indicators adapt to almost any process – easily changed ranges and calibrations – available with two or three position controls. Multi-point Switches permit connection to unlimited number of sensing elements.

Fast Response— Automatic, self-balancing, 2.5 seconds full scale travel.

Accuracy – Guaranteed ±0.25% of full scale – constantly maintained over long periods without adjustment, even under adverse operating conditions. Sensitivity, 0.125%!

Easy Maintenance – Fully gasketed, black-enameled case, sealed against atmosphere, dirt, contaminants. Pull-out chassis permits easy cleaning, inspection, adjustment. Constant voltage supply eliminates standardization and battery replacement.

Thermo Electric

Temperature Measuring Systems and Components

GET FULL DETAILS on the Thermo Electronic Self-Balancing Indicator. Write for Instrument Section 67 — 42

20 YEARS

THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

For more facts circle 291 on Reader Service card, p 101

Marmy rolls 'em

"Get Marmaduke Surfaceblow on the phone . . . and I mean *now*," yelled Philip Havermeyer, head of the Boiler Insurance Co's engineering dept, to his shapely secretary. "And shag your fanny, Lulu, this is IMPORTANT," he growled between puffs on a long cigar he was chewing and smoking at the same time.

The year was 1918, eight hectic months after America started tooling up feverishly for World War I.

"Ahoy matey, what's this . . . abandon ship?" the boiler inspector's gravelly voice rasped out of the phone an hour later. "You'd think we were being torpedoed." The rumble reached Hartford all the way from the chief engineer's office at the Continental Mfg Co in Cleveland, where the phone had finally caught up with Mr Surfaceblow.

"Cut the sarcastic stuff, Marmy," hissed Havermeyer into the phone on the Hartford end. "This *is* war. Now listen, you muscle-bound pirate: the New England Textile Co in Manchester, N.H. dry-fired their boilers last night. And every last tube is burned out of their two watertubes and hanging like so much spaghetti. Know what that means?"

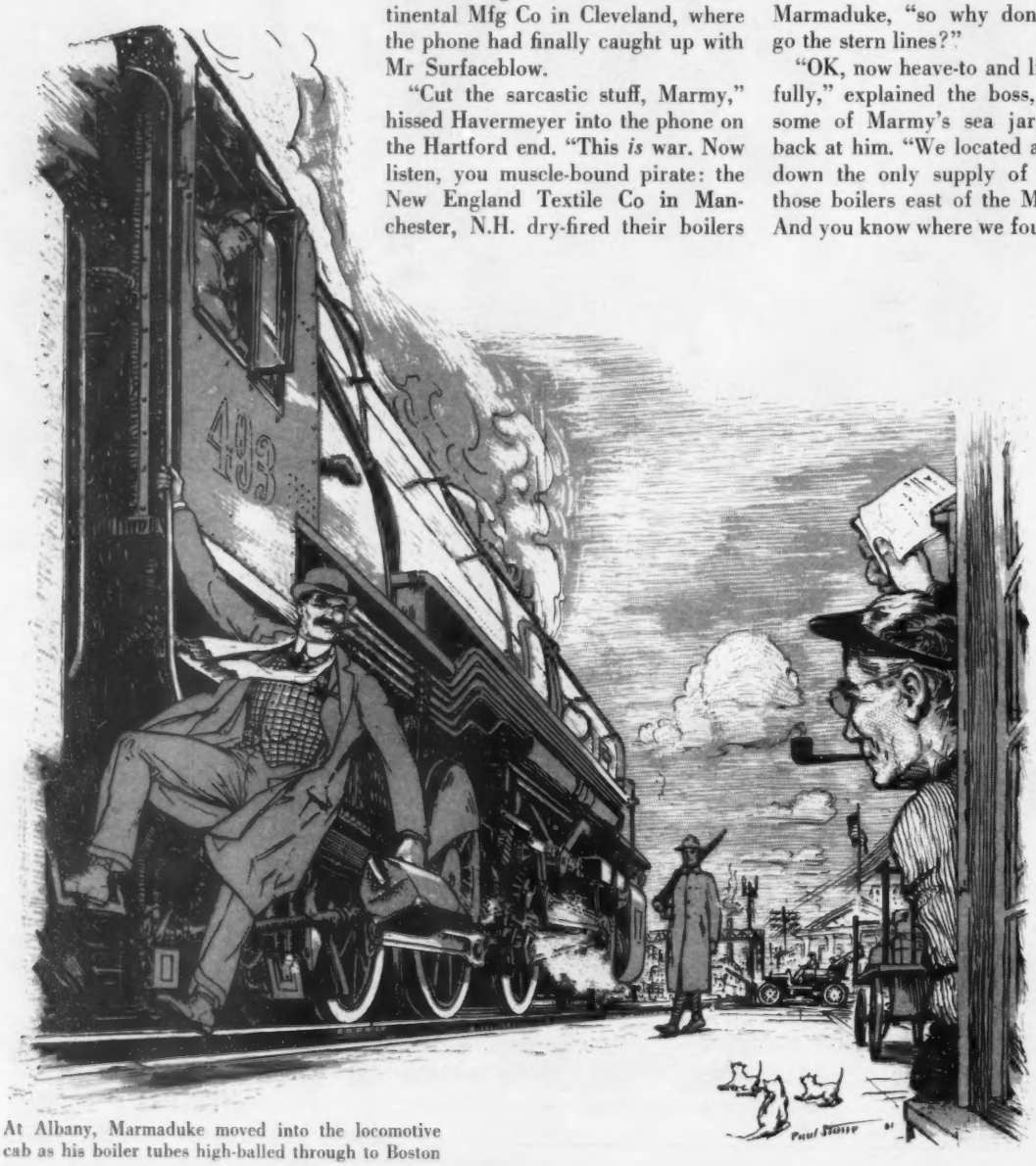
"Sure," came back the quick answer, "they'll have to cover up the brass monkey tonight."

"Do you know how much their use-and-occupancy clause is costing us for daily production loss while that mill's shut down?" raged Havermeyer. Without waiting for another whimsical answer, he sputtered, "$80,000 a day! And what's more, we're holding up the war effort. They're working 100% on textiles for the army. Are you still aboard?"

"Aboard and steaming full speed ahead under forced draft," barked Marmaduke, "so why don't you let go the stern lines?"

"OK, now heave-to and listen carefully," explained the boss, throwing some of Marmy's sea jargon right back at him. "We located and nailed down the only supply of tubes for those boilers east of the Mississippi. And you know where we found them?

continued



At Albany, Marmaduke moved into the locomotive cab as his boiler tubes high-balled through to Boston

ONE OF A SERIES OF CHATS ABOUT THE CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

WHY THE BIG STRAIN?

It's tough to keep gases and liquids "clean" as they run through a pipe. They drag impurities along, which can make even plain water a trouble maker, let alone more sophisticated fluids. That's because water, as a liquid or steam, is intimately involved with vital equipment like steam traps, temperature regulators, or tools. Meters, burners, nozzles, and pumps, too.

By this time you must realize we're going to talk strainers, don't you? A good, stout subject, of interest to all who feel production belongs up and costs belong down. Sarco makes strainers for water and condensate, steam, oil, air, gas and other piped fluids . . . dozens of different sizes and types and ratings of strainers to match every application need. Even our line of plain and simple strainers is built for super service. These are pipeline strainers, types AT, BT, and CT, which are designed for 250, 250 and 600 psi non shock, respectively, and 475°, 450° and 750°F. temperature ratings. Standard screens are heavy-gauge, perforated brass or stainless steel. Sarco specializes in screens that can withstand abnormal pressure differentials created by accumulated sediment.

Next, Sarco's flanged strainers, type D. These come in larger sizes, right up to 12", and are available in standard or extra heavy types.

And finally, *Sarco scraper strainers*, manual or motorized. These are the really eye-popping models, and if you can't use one yourself — well — you'll just have to get your kicks elsewhere.

Examples? Take Inland Steel Company at East Chicago, which gets water from Lake Michigan to cool its large air conditioner condensers. The water used to pass through traveling screens, but still contained fine sand. Clogging!

Heat under collars! Frequent cleaning required! Sometimes practically no air conditioning on hot days. (Isn't that always the way?)

The Inland Steel people installed Sarco Rotary Scraper Strainers, Type VRS, which incorporate a hand-operated helical scraper knife within the cylindrical strainer screen. A few turns of the crank at regular intervals, and the sand is scraped off the screen, blown clear, and discharged at pressure through a manual valve to waste. Dismantle the strainer? Shut down the unit? Not *this* strainer!

Now, as long as we've come this far, it's only a hop and a skip to the Firestone Tire and Rubber Co. in Akron, Ohio, who also use water in tremendous quantities. They circulate it through tire presses and a cooling tower, and there's no nonsense about it. It *has* to be clean or damage to equipment could be downright catastrophic. When the plant

modernized and enlarged, Firestone replaced their 4" Sarco hand-operated scraper strainer, type VRS, with a larger Sarco 8" model. And while they were about it, they got the motor-operated type, for continuous cleaning.

When we say that companies like these want the insurance of a Sarco strainer, it sounds like advertisingese, but sometimes there just isn't any other way to put it. Sarco strainers *are* insurance at low cost on the operation of your high cost equipment. So when we ask if you have lumps in your pumps, or worries over your slurries, we're *serious*. We've heard everything in the straining line, so why not write us for literature and answers to those special problems you have.

A T-44 IS THE BEST POLICY

Sorry, but we can't leave the subject of insurance without bringing to your attention one of the best little insurance policies any company requiring cooling control could invest in. It's the *self-powered* Sarco T-44 Automatic Cooling Control. No compressed air or electricity is needed, but its advantages are best described in terms of three different plants of just one Sarco customer — Revere Copper and Brass, Inc.

Revere-Baltimore, Md., has cut water use 40 to 50% with T-44's. But in addition to former water waste, Revere had even more problems: possible wet air from uncontrolled cooling of compressor aftercoolers, plus sweating compressor cylinders; variations in viscosity of hydraulic oil and bearing oil; gas generator water waste; unreliability of manual shut-off of water supply when machines were down.

If your ears perk up in sympathy at mention of any of these problems, the results of Revere's cooling control program should bring you to full attention. One large compressor that had gulped 2400 gallons per hour now takes only 420 gallon sips. In addition all the problems itemized above were solved. T-44's are now used on their air compressors, gas generators, and hydraulic oil systems. At Revere-Riverside, Cal., water savings of 50% were experienced, and at Revere-Rome, N. Y., substantial savings were made too.

But after all, wasting water is only one way of wasting money, so let's go on to another matter of interest: the evils of manual control. When cooling water is controlled by hand the temptation to leave the valve nearly wide open is almost overpowering, in order to play it safe if the load varies. Result: overcooling, of course. And varying the flow runs the risk of undercooling. In either case, lowered process efficiency. Answer: The automatic Sarco T-44, which can't be tempted, is meticulously honest, unsentimental, and plain inhumanly practical when it comes to cooling control. You really ought to write for literature. T-44 is your best policy.

SPARE PARTS INSURANCE

As long as we're near the end, and still on this subject of insurance, may we graciously leave you with this valuable tip? No matter how closely a steam trap approaches perfection, some gremlin may cause it to act up. It's conceivable. So, keep on hand a parts list and spares of key parts for your steam traps and other system components. Parts are small and worth their weight in gold when you need them. A Sarco field engineer will make up a suggested list for you, if you tell us what components make up your system.

Might as well even keep a disc or two on hand for your Sarco Thermo-Dynamic Steam Traps, Type TD-50, even though they're so trouble-free our salesmen keep complaining about the lack of replacement parts business. We'll be glad to tell you about this unique steam trap in case you still don't know how miraculously simple and effective it is.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both — to the point where you'll communicate.

5903

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

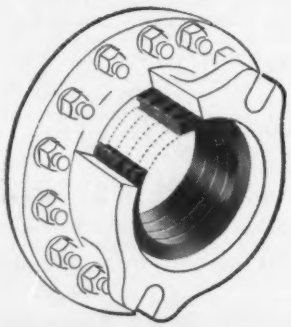
For more facts circle 292 on Reader Service card, p 101

HOW SEVENEERING WITH R/M CUTS MAINTENANCE COSTS, PROTECTS RODS IN STEAM FORGING HAMMER APPLICATION

AVERAGE R/M PACKING LIFE 3 WEEKS, former packings only 1 week. And the R/M Vee-Square eliminated two packings because it is available in sizes to fit any hammer rod, stuffing box and packing gland. It's also uniform and easy to install.

43 hammers with R/M Vee-Square® Packings 15% savings in replacement packing costs

Here is a good example of SEVENeering with R/M. The Transue-Williams Steel Forging Corporation, Alliance, Ohio switched to R/M Vee-Square Packings for its 43 forging hammers at the recommendation of an R/M Distributor.* This move resulted in savings of 15%.



In addition, inventory was reduced — all makes of hammers in the plant now use R/M Vee-Square instead of three types. Pressure efficiency in the hammers is constant. A positive seal is maintained through stroke and return by R/M's Vee-Square, which combines the nonyielding properties of solid packing with the automatic sealing of V-ring design. Destructive and costly rod scoring is eliminated. Little gland adjustment is required, dry spots on the packing surface do not occur, and snug fit contributes to uniform rod wear.

Transue-Williams is but one of thousands of plants SEVENeering with R/M to solve their packing problems. Our Big 7 Packing Selection Chart is a helpful guide to the selection and application of R/M Packings for all types of equipment. Write for your copy today. See your authorized R/M distributor for immediate requirements now. He will make suggestions, and supply the packings you need — usually from stock.

The Alan Packing & Rubber Co., Cleveland, Ohio

R/M's Big 7 Packing Types meet 95% of all packing needs, are sold exclusively through authorized R/M distributors

RAYBESTOS-MANHATTAN, INC.
BIG 7 PACKINGS
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Marmaduke

Begins on page 148

Right in your own back yard, at the Cleveland Steel Tube Co. Are you standing by?"

"Aye aye, sir, and waiting for orders," roared Marmy, lighting a piece of rope yarn and tossing his gray bowler on the chief's desk as he stretched out his long legs.

"You're ordered to get those kettles shipshape," shot back the boss. "You arrange for shipment and ride with the tubes to Manchester—they're worth their weight in ambergris. Then hire local boilermakers, roll in the new tubes and get the boilers steaming. That means working watch-and-watch — but I'm depending on you. There's a fat bonus waiting if you cut red tape and get that plant in operation quickly."

Before Marmaduke could reply, Havermeyer added, "I don't care how you do the job—but get it done. And I'm not counting pennies. Pick up $2000 for pocket money at the Ohio Trust Co—I'll call them."

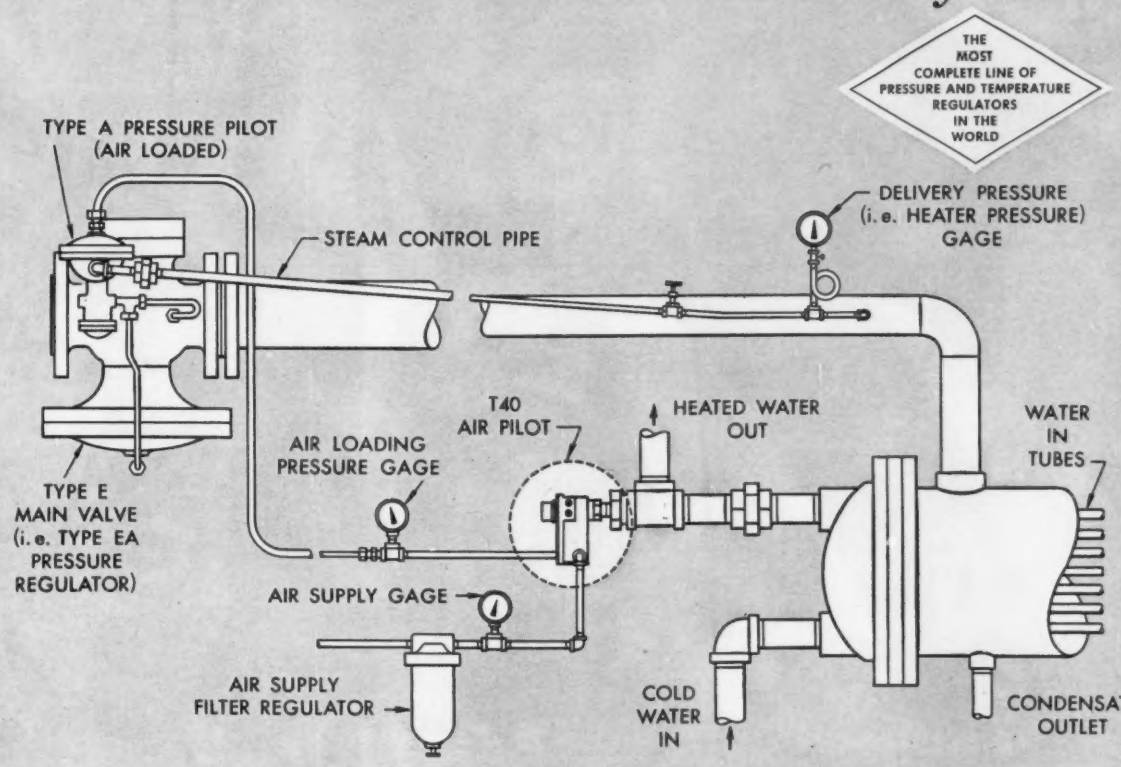
"Sounds like a South Sea Island picnic," laughed Marmy, envisioning that bundle of beautiful folding money. "What's the problem?"

"It's *no* picnic, and you *got* problems, Mr Surfaceblow," howled the boss. "They're big ones. Don't forget the army's running the railroads now. You evidently don't know that since the swivel-chair cavalry took over, every trunk line and siding is blocked with freight cars for a hundred miles back from the eastern ports. Movement from one railroad division to another can be delayed for weeks. Are you still at the throttle?"

"The sun's sizzling through the fog," assured Marmaduke, as he started to check some Boston phone numbers in a little black address book he fished from his vest pocket.

"Well," heaved Havermeyer, "that's only problem No. 1. Here's No. 2: Mr Orziel Ezra Lype, president of the mill, is popping his rivets. He's been calling me every hour. Wants those boilers back in operation right now —as if we didn't. He blames that dry firing on us—raves we didn't warn their unlicensed operators about something — I'm not sure exactly what. He also says if we have as much brains as a chimp we'll get those

New Spence Temperature Control System Gives Unusual Control Accuracy


THE MOST COMPLETE LINE OF PRESSURE AND TEMPERATURE REGULATORS IN THE WORLD
TYPE A PRESSURE PILOT (AIR LOADED)
STEAM CONTROL PIPE
DELIVERY PRESSURE (i.e. HEATER PRESSURE) GAGE
T40 AIR PILOT
HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
TYPE E MAIN VALVE (i.e. TYPE EA PRESSURE REGULATOR)
AIR SUPPLY GAGE
AIR SUPPLY FILTER REGULATOR
COLD WATER IN
CONDENSATE OUTLET

TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

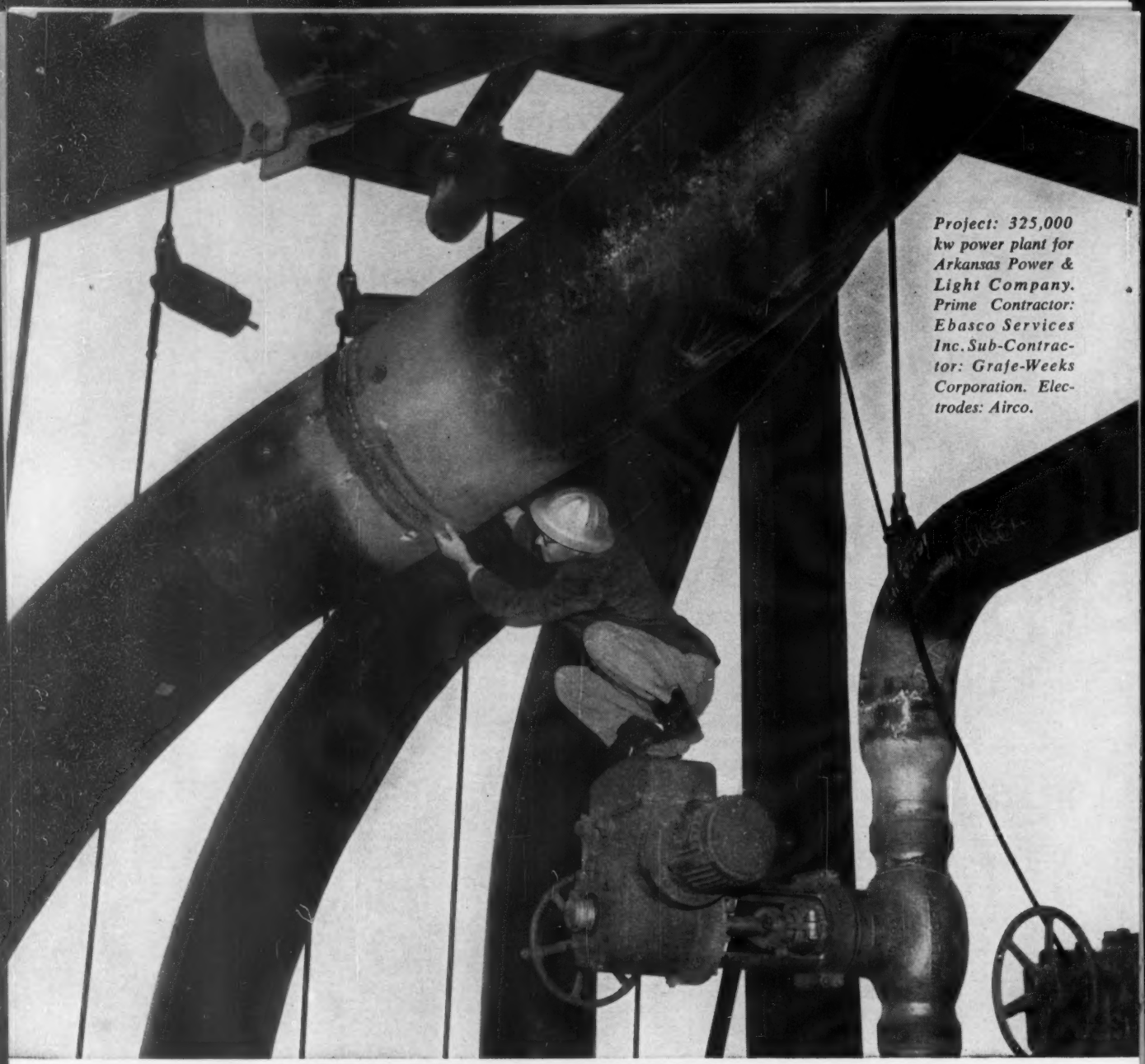
Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden 1, New York

SE-140

For more facts circle 294 on Reader Service card, p 101



Project: 325,000 kw power plant for Arkansas Power & Light Company. Prime Contractor: Ebasco Services Inc. Sub-Contractor: Grafe-Weeks Corporation. Electrodes: Airco.

AIRCO LOW HYDROGEN ELECTRODES USED ON HIGH TENSILE PIPE WELDING *at giant new power station*

AIRCO LOW HYDROGEN ELECTRODES were used by Grafe-Weeks Corporation to weld the hundreds of feet of high pressure piping in the giant new steam turbine power plant of the Arkansas Power and Light Company at Helena on the Mississippi.

Why? . . . Because Airco low hydrogen electrodes provide an easily directed arc specifically designed to meet requirements of high pressure pipe welding . . . They also deliver X-ray quality deposits under tough conditions.

Ask for a shop demonstration. Would you like to see Airco electrodes put to the test? Let your Airco salesman or distributor arrange a demonstration at your convenience . . . using Airco low hydrogen electrodes or any other group of Airco electrodes. Call Airco, or look in your Classified Telephone Directory under "Welding Equipment and Supplies" for your nearest Authorized Airco Distributor.

AIRCO

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A division of Air Reduction Company, Incorporated

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More than 700 Authorized Airco Distributors Coast to Coast

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For more facts circle 295 on Reader Service card, p 10!

Marmaduke

Begins on page 148

tubes there, roll 'em in and have the boilers steaming by yesterday. That's how crazy he is. He called just now and accused us of handing the war to Kaiser Bill on a silver platter. So you'd better watch out for Mr Lype —he'll throw roadblocks in your way."

Marmaduke had his job cut out for him, and he admitted it to himself soon as the boss hung up. He had brought many a beatup ship into port after a storm in his sea-going days, but this business with the railroads was sailing on uncharted waters. Or was it? Anyway, his job was to carry the message to García, and he meant to do it.

Minutes after the phone call, Marmy screeched up to his rooming house in a cab. He stuffed his traveling bag with one clean shirt, one pair of long underwear and nine bottles of Sandpaper Gin. Three hours later he was watching a railway car being loaded with the precious boiler tubes.

His next problem: destination Manchester. The peppery army colonel holding down the dispatcher's job at the freight yards was a man of few words. He didn't give a continental how important Marmy's shipment was. His yards were full of freight waiting to roll east. Maybe in three or four days he could get those boiler tubes up to Buffalo on the New York Central. From there, it was up to the Buffalo dispatcher to shove them to Rochester. Then Syracuse and Utica were two horses of another breed, but once the shipment got to Albany, Boston was only 200 miles away. Of course, it was anyone's guess when that car could leave Boston for the last 60 miles to Manchester on the Boston & Maine RR.

"What's wrong with shipping on the Erie directly to Binghamton and then through Albany to Boston," asked Marmaduke, searching the large railroad wall map for the shortest route. "Why not skip all those New York Central tank stops and go direct to Boston?"

"Ha ha ha," snarled the colonel, "I'm using that through line only for high-priority military express. There's a war going on and no boiler tubes are going on that line, Mister. Let's get that straight."

But three hours later Marmy and the colonel were winding up a sumptuous meal with appropriate refreshments at the lush Erie Lakeside Café in Euclid. Then followed wild taxi rides to a few of the better-known night spots, accompanied by some cuties they had accumulated along the way. At all these places, Marmy lavishly gave the headwaiters the well-known green-flag treatment.

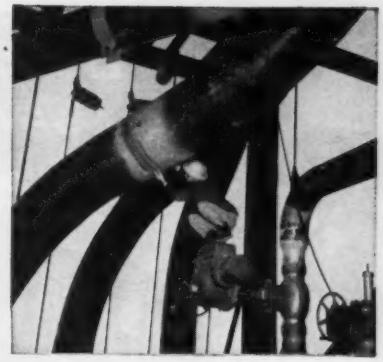
By midnight the colonel had become so absent-minded about his high-priority shipments going east on the Erie that Marmy's car was spotted, not onto a fast freight to Buffalo, but between the locomotive and mail car of the next passenger express high-balling through to Albany. And the boiler inspector had himself a first-class berth in one of the pullman cars reserved for military personnel.

At Albany, Marmy found the army dispatcher much more receptive because the colonel had called him from Cleveland. After another evening— this time at Albany's famous Keeler's —this dispatcher, too, became absent-minded and the tubes were once again high-balling toward Boston. This time the muscular gentleman with the checkered vest, the gray bowler and the 5-star hangover rode in the locomotive cab with the engineer.

The Boston & Maine dispatcher was the toughest nut to crack. But he, too, was finally mesmerized. This time a few bottles of superheated liquid tucked into his hot hands did the trick. As a result, the boiler tubes arrived alongside the textile mill in Manchester in the incredible time of only 39 hours. By then our hero was down to $800 and three bottles of Sandpaper Gin.

Then started problem No. 2. And it was a real toughie. But that same cold gray dawn found Marmy loitering in the vicinity of a shipyard in Quincy harbor, adding some green-flag magic to his joy-juice technique. And later that morning, two of the hardest-working and healthiest boilermakers of the yard reported sick for the first time.

So far Marmy was ahead of schedule, any way you looked at it. But he needed the margin for error, because Orziel Lype had by then turned



For your low hydrogen welding— Airco electrodes meet every critical need

Here are the Airco low hydrogen headliners — from a total of more than 100 Airco electrode types in more than 400 sizes and designs —

AIRCO 312 AWS-ASTM E60-7016. For welding higher strength alloy or carbon steels. Also high sulfur content steels. Designed to overcome "underbead cracking." Lessens need for high preheat or stress-relieving postheat.

AIRCO 396 AWS-ASTM E8016-C1. For welding the 2½% to 3½% nickel steels used in low temperature jobs. Also for nickel bearing steels, to provide uniform chemistry at joints with minimum difficulty. No high preheat needed.

AIRCO 395 AWS-ASTM E8016-C3, A 1% nickel type of low hydrogen electrode. Also for nickel bearing steels where good low temperature properties can be attained; high sulfur content steels; grade HT and similar high tensiles.

AIRCO 394 AWS-ASTM E10016-D2. For welding manganese-molybdenum high strength steels such as A-302 Grade B.

AIRCO 354 AWS-ASTM E8016-B2. For welding 1.25% chrome 0.5% molybdenum steels used for pressure vessels in high temperature service; and for castings of similar analysis.

NOW — "Barrier Carton" bars moisture damage. Special aluminum foil interlining in new carton now protects dryness of Airco low hydrogen electrodes *8 times better than regular style carton.* If your application can't tolerate moisture damage...specify Airco.

AIRCO

AIR REDUCTION SALES COMPANY

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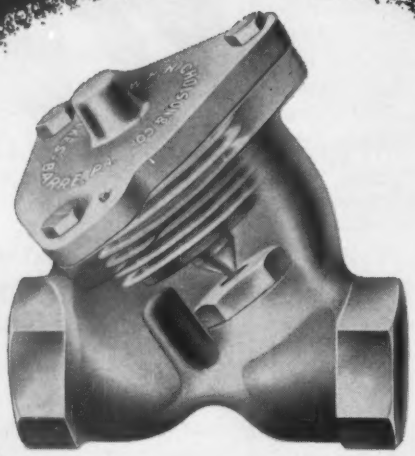
150 East 42nd Street • New York 17, N. Y.

A NEW DEVELOPMENT

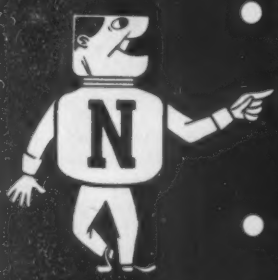
FOR STEAM-SAVING EFFICIENCY



Nicholson Thermostatic Steam Trap Model N-150

- ALL STEEL CONSTRUCTION
- JUST ONE WORKING PART
- RUGGED MONEL BELLOWS
- NEW BAFFLE* . . . deflects steam upward and away from the orifice to surround the bellows

- FREEZE PROOF WHEN INSTALLED VERTICALLY



- CAN BE TESTED AND INSPECTED WITHOUT BREAKING PIPE CONNECTIONS
- COMPACT, LIGHTWEIGHT, EASY TO INSTALL
- FOR TRACER LINES also Plating Tanks Platen Presses • Unit Heaters • Sterilizers and various types of Cooking and Laundry Equipment. N-150 Traps can also be used as air vents for Receivers, Water Heaters, Mechanical Traps, etc.

- W. H. NICHOLSON AND CO.
12 Oregon St., Wilkes-Barre, Pa.

* Patent applied for

Marmaduke

Begins on page 148

into a raving maniac because of his shut-down mill. As if that wasn't enough trouble, Marmy discovered that many of the tubes in those ancient boilers had been rolled in so often that the tube holes were oversized. The only answer was to place a ferrule around each tube end.

It was late at night when the tubes were ready to be rolled. The two sick boilermakers had spent a hard day working with a half-dozen mill mechanics. They had chiseled out all the old tubes and cut the new ones to correct length.

"I don't care *what* your problems are," yelled the irate Lype, barging into the boiler house for the dozenth time. "If you call yourself an engineer, nothing will stop you. NOTHING! Understand?" With that he stormed out of the boiler house and back to his cold office.

But there wasn't any sheet iron of the right thickness. And those boiler tubes needed a lot of ferrules. So Marmy went scrounging about the mill buildings in the light of a full moon, headed for the scrap pile. Suddenly a silhouette rose before him: Lype's big Rolls Royce. Lifting one side of the long engine hood, Marmy felt the thickness of the well-polished metal.

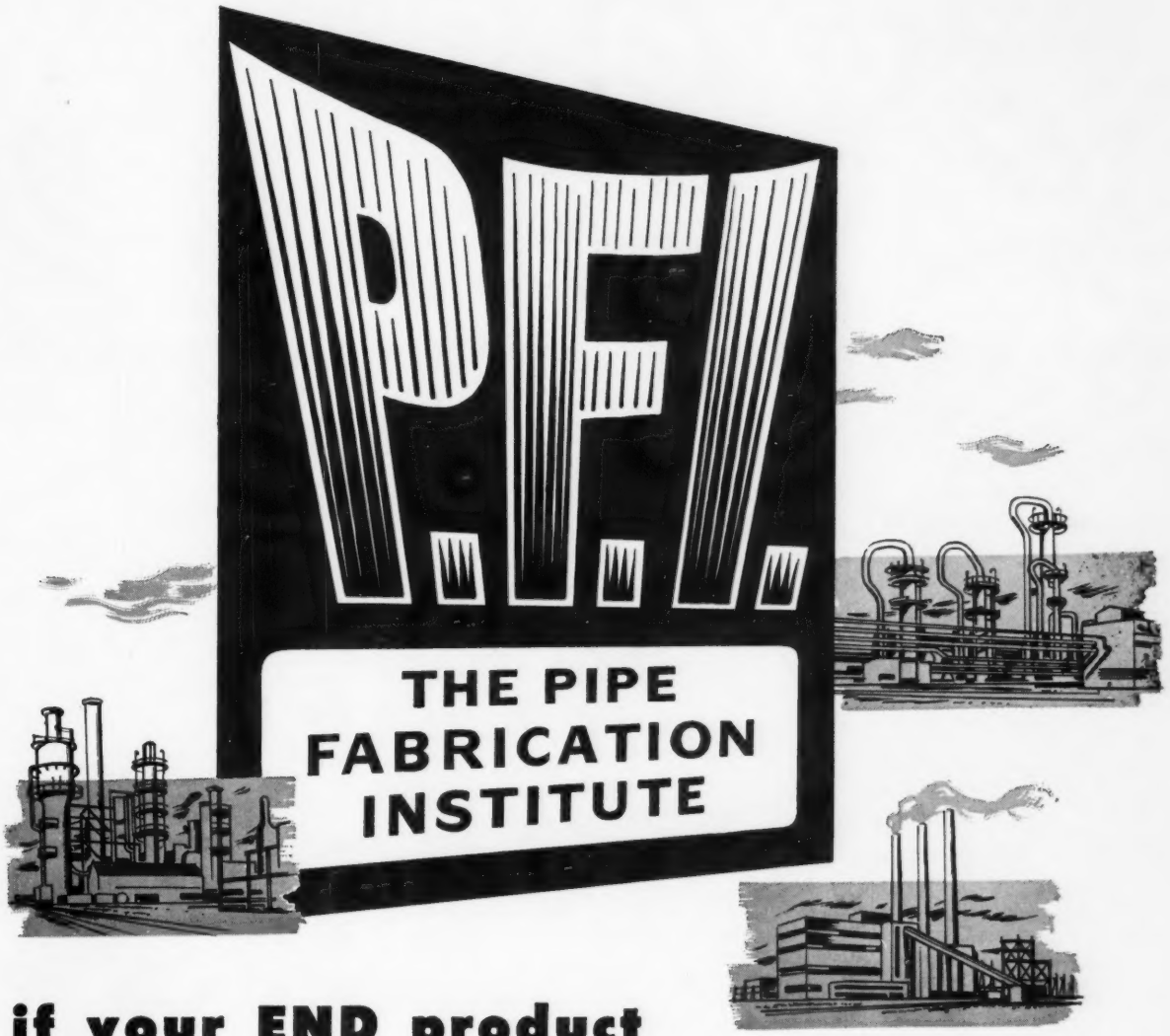
"Well, I'll be a red-headed mermaid's twin sister," Marmy murmured to himself with great satisfaction. "This is the answer to a sailor's prayer. Talk about manna from heaven!"

A few minutes later the two pirated boilermakers were happily removing varnish from the large hood. Then Marmy's helpers gleefully gave the hood the heavy-shears treatment, cutting it into 1-inch strips.

Next started some really feverish activity. Tubes were rolled in like crazy. With each pocket of his overcoat stuffed with a bottle of Sandpaper Gin, Marmy prowled back and forth. He rode herd on his gang, pepping them up from time to time by thawing out their cold limbs with his bottled thermal liquid. Then each time fatigue slowed down a mechanic, Marmy would wave a small green flag to fan life into him.

At midnight, Orziel Ezra Lype came storming into the boiler house.

continued on p 160



if your END product BEGINS with piping...

Proper piping is always important for the accurate flow and control of high temperature or high pressure gases and liquids.

The selection of the piping material and its fabrication to specific forms can be costly for the original installation, but it can be even more expensive if it requires frequent maintenance, short-term replacement or if it fails to contribute to the economical production of your end product.

So, it is vitally important that your piping requirements be handled from blueprint to finished fabrication and assembly by thoroughly experienced and dependable piping specialists.

Members of P.F.I. are best qualified through coordinated research and advanced technology, and their individual fabrication facilities, to provide you with the most practical piping for long life and the economical production or handling of your products.

PIPE FABRICATION INSTITUTE • ONE GATEWAY CENTER • PITTSBURGH, PA.

Simply circle the Standards you can use and mail to PFI at the address above.

1 Machining Backing Rings for Butt Welds
2 Dimensioning Welded Assemblies
3 Linear Tolerances Bending Radii
4 Shop Hydrostatic Testing
5 Cleaning Fabricated Piping
6 Built-up Weld, Metal Bosses
7 Welded Nozzles — Spacing
8 Preheat - Postheat Welding, Low Chrome — Moly Pipe
9 Arc-Welding Dissimilar Ferritic Steels
10 Stress Relieving Practices
11 Affixing Permanent Symbols to Piping
12 Preheat - Postheat Welding, Medium Low Chrome — Moly Pipe
13 Classification, Shop Testing, Inspection, Cleaning

For more facts circle 353 on Reader Service card

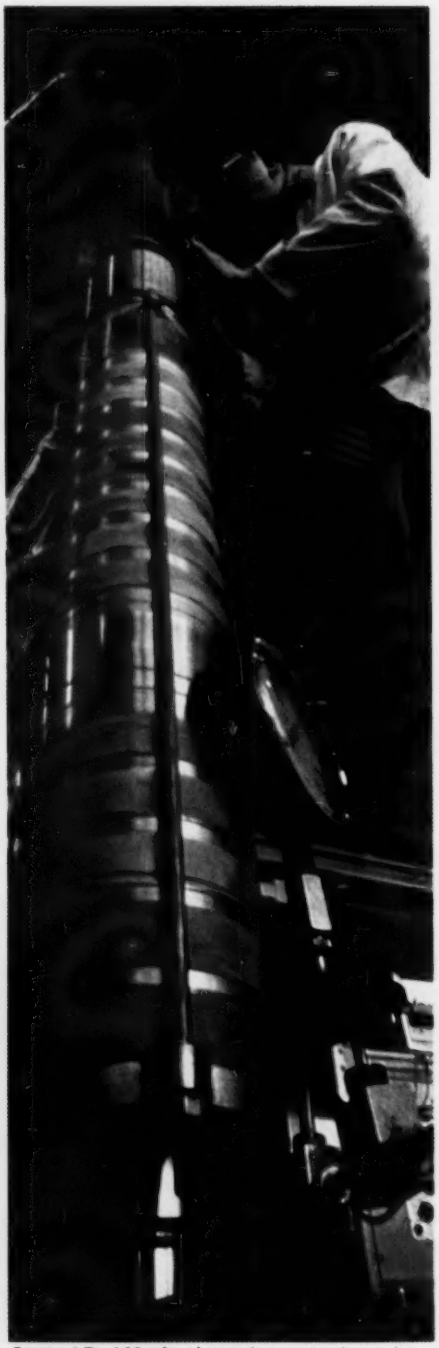
Westinghouse supplies all these vital mechanical components for nuclear reactor plants

Canned Motor Pumps. This skilled technician is machining a canned motor pump shell and flange on a modern 100" vertical boring mill. Pump is an important nuclear reactor component.

Quality Control. All equipment manufactured by the Atomic Equipment Department is subjected to maximum quality controls. Stringent hydraulic, electric and mechanical inspections result in essentially maintenance-free performance.

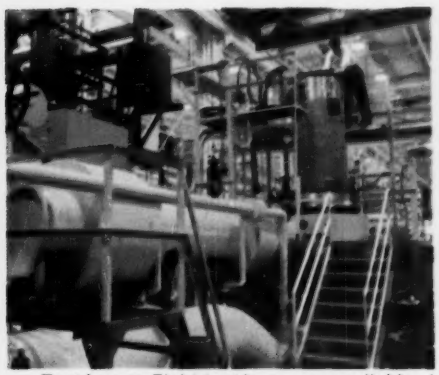
Nuclear Reactor Valves. This 20" motor operated gate valve has been machined and is ready for testing before shipment for SELNI in Italy. Valve is one of many Westinghouse designs for reactor plant primary systems.

Modern Production Facilities. Advanced production and testing equipment in modern plant at Cheswick, Pa., make Westinghouse Atomic Equipment Department the most complete facility of its type in the world.



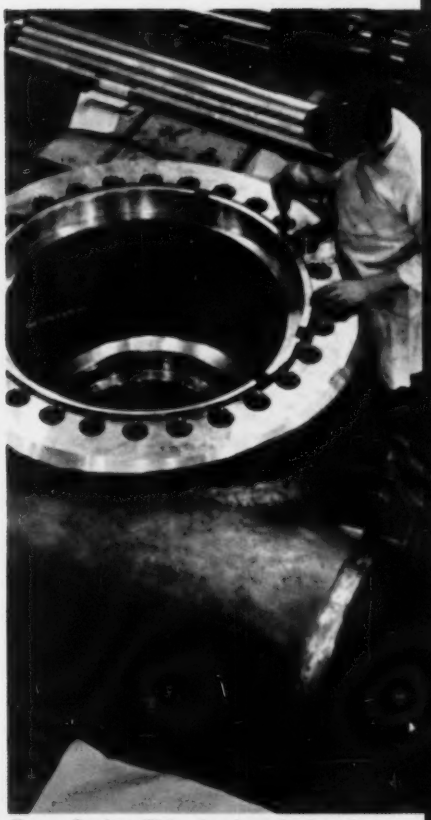
Control Rod Mechanisms. Inspector is working on a control rod mechanism to be installed in new Saxton, Pa., reactor. Moving parts of mechanism are hermetically sealed.

...and canned pumps for controlled circulation boilers

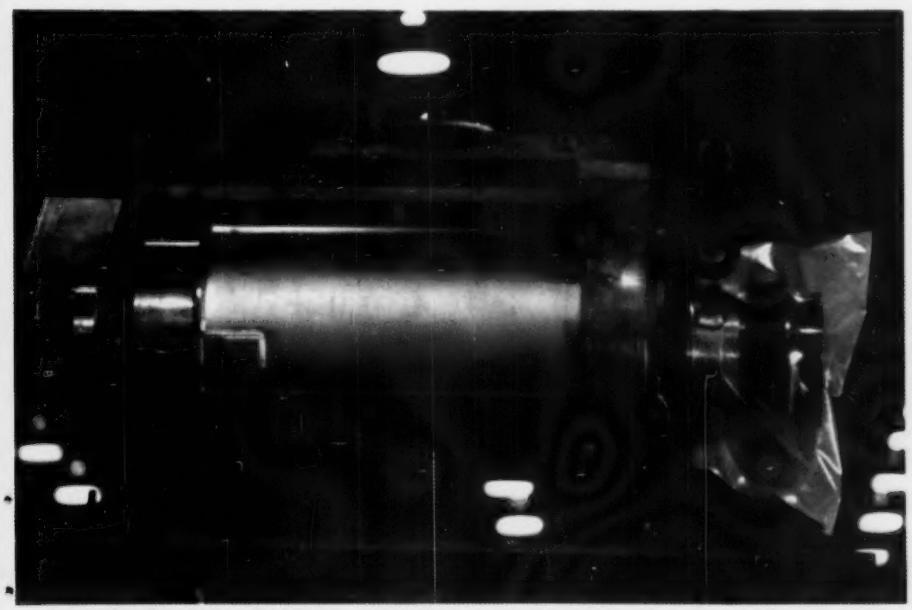


Test Loops. Eight test loops are available at the Atomic Equipment Department for rigid testing of all products. Loops can be adapted to handle flows from 1 to 40,000 g.p.m.

Westinghouse Pumps Installed. Three Westinghouse canned motor pumps are shown installed in power plant in Hartsville, South Carolina. Motor and pump casing completely enclose the pump shaft, eliminating the problems of the seal-injection system.



Pump Casing. This nine-ton steel casing will be installed with a canned motor pump in a nuclear reactor plant. Casing and pump form a leakproof unit.



Controlled Circulation Boiler Pumps. Westinghouse manufactures canned motor pumps such as this for service with Combustion Engineering controlled circulation boilers. Standardized pumps are available in many head and flow combinations for these high temperature, high pressure boilers.

You can be sure if it's

Westinghouse

For more facts circle 354 on Reader Service card

J1-59005

Introducing:

A remarkable new series of 2½-inch gauges

Actual Size

MARSH

Service Gauge

Quality...Accuracy...Stamina — along with real economy!

Here is a life-size illustration of today's best answer to the need for a 2½-inch gauge of high quality, guaranteed accuracy, sturdy construction and advanced design . . . and along with this unprecedented value and economy made possible by Marsh manufacturing facilities and resources.

All of these gauges have sturdy, black bonderized cases with blow-out plugs and brass screwed rings with bevelled glass as used on the finest Marsh Gauges. This screwed ring gives easy access to the "Recalibrator" which is standard on *all* "Service Gauges."

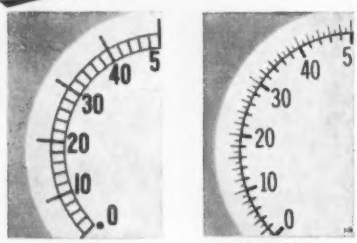
Every gauge is *guaranteed accurate within 1% of dial reading.* All have the "Read-easy" dial as used in the finest Marsh testing gauges. Ranges are 15—30—60—100—160—200—300—600— and 1000 pounds; also 30" vacuum. All are standard with ¼" male bottom connection. Two types are available to cover a wide range of uses:

Type 11 is for media not corrosive to brass. It has a silver-brazed copper-alloy bourdon tube, and the excellent bronze-bushed movement so well respected in the Marsh "Quality" line.

Type 11S is for corrosive media where stainless steel is indicated. It has a 316 stainless steel bourdon tube with 303 stainless steel tip and socket. Movement is the finer stainless steel and monel type.

Get all the facts about this remarkable new example of Marsh quality and value.

Ask For New Bulletin



"New look" in dials

Marsh "Read-easy" dial has twice as many calibrations as old style dial, but is read more easily and accurately.

ALL THIS:

- Sturdy bonderized case
- Brass screwed ring with bevelled glass
- "Recalibrator" standard
- New "Read-easy" dial
- Copper alloy bourdon tube, silver brazed—or —stainless tube with 303 stainless tip and socket.
- Bronzed bushed movement—or—stainless steel and monel movement.
- Ranges of 15—30—60—100—160—200—300—600—1000 lbs. and 30" vacuum. ¼" bottom connection.

MARSH

"THE STANDARD OF ACCURACY"

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Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada.
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.
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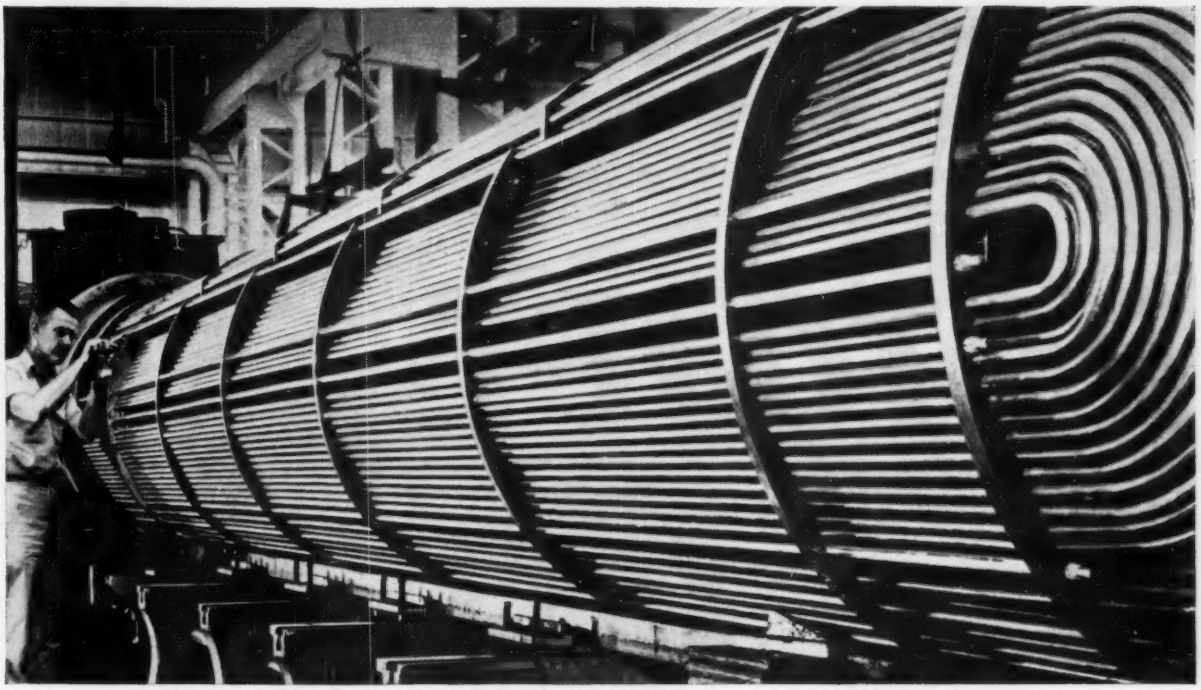
GAUGES • THERMOMETERS • VALVES



What kind of tubing do modern feedwater heaters need?

Tubing for today's feedwater heaters must be strong to handle higher pressures and temperatures in modern steam plants. It must be made of a corrosion-resisting metal with good heat transfer properties. It must be workable and weldable to permit bending and attaching to tube sheets. In addition, it must insure long, trouble-free service.

There's one tubing material – Monel* nickel-copper alloy–that offers all these advantages:

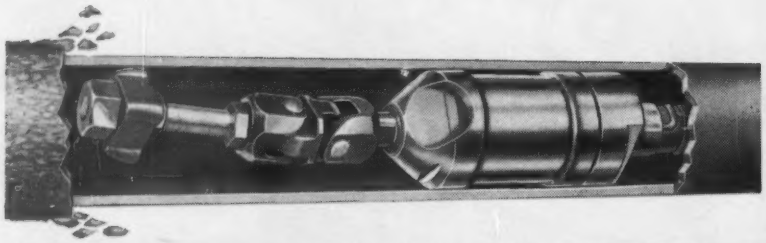
- **Higher design stresses.** Without increasing tube wall thicknesses, stress relieved Monel tubing can be used for higher pressures. The latest revision to ASME Boiler Code, SB-163, allows an increase of approximately 5% in existing design stresses.
- **Better all-around corrosion resistance.** Monel resists corrosion by waters of all sorts.
- **High ductility.** Monel has good ductility for rolling and bending – permits unannealed tube ends. High ductility means tight rolled joints, and ease of forming hairpin bends.
- **Easy weldability.** Welding Monel alloy tubes to steel tube sheets is no problem. The alloy fuses well to form a strong, sound weld. Its coefficient of expansion is close to that of steel tube sheets.
- **Product quality.** Continual inspection and testing from refinery furnace to finished form result in the unvarying quality of Huntington Alloy Products tubing.
- **Long length tubing available.** The automatic cold draw bench at Huntington Alloy Products mill makes Monel tubes *as long as 85 feet!* This enables designers to take advantage of greater heating area in the tube bundles, and to effect economies by specifying longer heaters of smaller diameters.
- **Prompt deliveries.** With new facilities in full operation, prompt deliveries of your Monel tubing requirements can be assured. Special attention will be given to retubing jobs, where prompt delivery is important. Orders are accepted on a basis of 8 week delivery.

Keep Monel alloy in mind when you design or retube a high pressure heat exchanger. For more information on Monel alloy, write for bulletin T-5, "Engineering Properties of Monel and 'R' Monel Alloys." *Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

MONEL®

For more facts circle 297 on Reader Service card, p 101



ROTOJET®

Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸▸

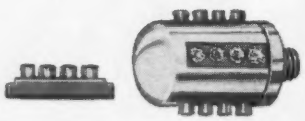
INSIDE *and* **OUTSIDE**

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

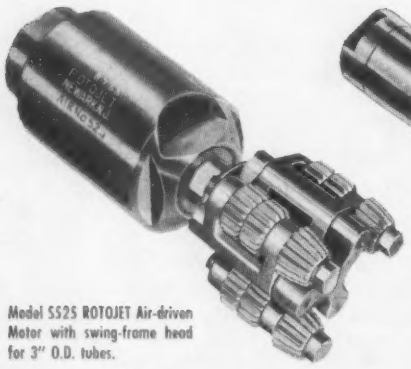
Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.



Model SS2S ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model SS0S ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910
1071-53 Bristol Road, Mountainside, N. J.

For more facts circle 298 on Reader Service card, p 101

Marmaduke

Begins on page 148

Talk about lightning hitting the outhouse. That guy had blood in his eyes and murder in his heart.

"What dirty low-down bastard stole the hood off my Rolls Royce?" he stammered, his eyes bulging from his head.

"BILGEWATER," purred Marmaduke in his foghorn voice. "No human being would stoop low enough to steal your hood. What could anyone want with a Rolls Royce hood?"

Just then Lype closed his mouth long enough to focus his eyes on the tube-rolling operation. His face turned a crimson color and he started to sputter like a shorted electric circuit. But all he could do was point at a shiny ferrule and sputter, "Rrrolllsss. . . ."

"That's right," barked Marmaduke. "As you said, Orziel, there's a war going on, and an engineer who's worth his hire won't let anything stop him from rolling in these tubes. NOTHING. Not even a Rolls."—*SME*

Marmy's mail

MARMY A HERO

Our ace engineer sure got up on a pedestal in February POWER. And that welding job he did on the boiler was all within the realm of possibility. I checked with a friend, who was a Navy electrical engineer during the war. He straightened me out about the degaussing system aboard ships.

Enjoyed the story and was happy to see that Marmy got his usual reward, plus a bonus from the attractive passenger.

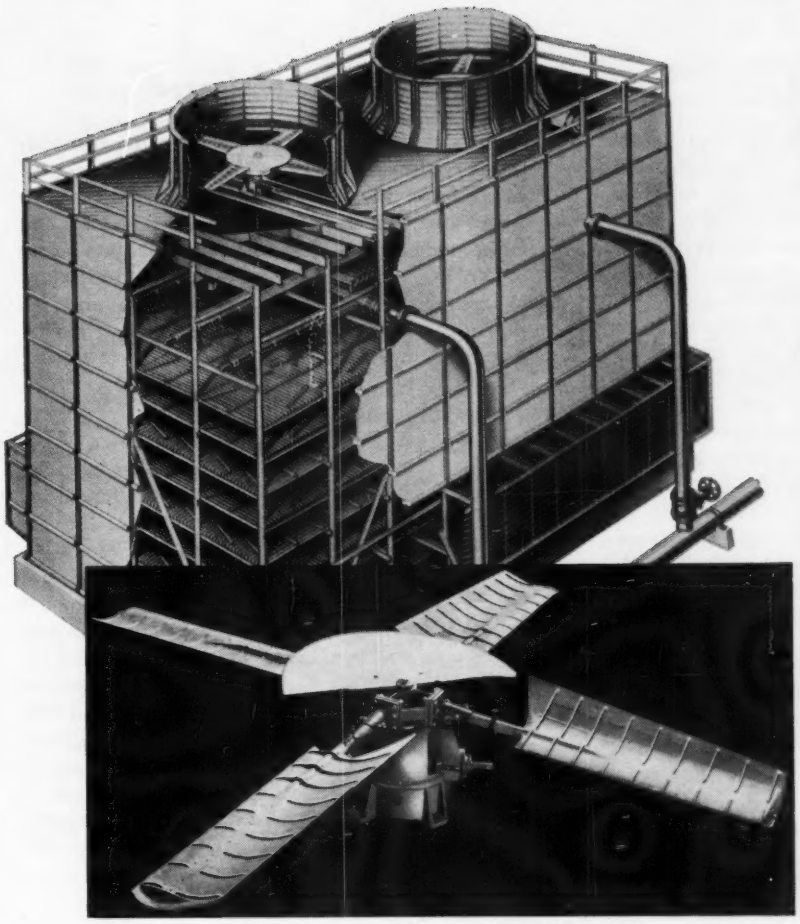
P ZIEMKE, *Clinton, Tenn.*

CARRIER CORP SAYS 'BRAVO'

Both Dick Arnold, our acoustical engineer, and I enjoyed reading the delightful Marmy story about the noisy table. We both say "bravo". Quoting Dick, the semifiction style of the yarn made reading it extremely interesting. But what's more, the story brought home the technical lesson with a bang.

R B FORD, *Syracuse, N. Y.*

FLUOR FANS



designed for highest cooling tower performance*

* Fluor aerodynamically designed fans have provided over 20 years' outstanding service, with the best performance record of any fan used in cooling tower operation.

For further information on Fluor Cooling Towers, write:

Fluor PRODUCTS COMPANY **COOLING TOWERS**

CTI

A division of The FLUOR CORPORATION, Ltd.

GENERAL OFFICES: P. O. Box 1267, SANTA ROSA, CALIFORNIA

For more facts circle 299 on Reader Service card, p 101

Powerscope . . . A selective look at

Ceramics may hold key

Ceramics may hold the key to building future magnetohydrodynamic (MHD) generators, say Westinghouse researchers. Westinghouse scientists now have run their 10-kw MHD unit for 50 minutes, more than 10 times the 4 minutes they previously reported. Most materials melt, burn up, oxidize, crack or erode away from the 5000-F ionized gas moving at 2000 mph that forms the heart of the MHD generator. Magnesium oxide performs well as an insulating lining material. Another ceramic, zirconium oxide, also stood up well. Zirconium silicate, beryllium oxide and other materials tended to melt, erode and crack. Among electrode materials, refractory metals such as tungsten, tantalum and zirconium were evaluated; they tended to oxidize or melt before the ceramic wall linings were seriously affected. Graphite erodes rapidly, though it has other excellent properties for MHD.

Floods of water

Survey of 542 steam-electric plants, with capacity of 25 mw and more, shows they used about 29-trillion gal of water for cooling during 1959. According to the Federal Power Commission, these plants generated 97.7% of the total national steam-electric output. This compares with 24-trillion gal used in 1954. The '59 figure represents about 23% of the nation's water withdrawals, which total in the neighborhood of 128-trillion gal. The water used by electric plants included 20.6-trillion gal of fresh water, 8.3 trillion of brackish, primarily from the ocean. Of the fresh water, 15.2-trillion gal came from rivers, 1.9 trillion from the Great Lakes and 3.3 trillion from other lakes and surface sources. More than 5-trillion gallons recirculated through cooling towers and spray ponds. On the average 61.7 gal were used in 1959 for each kwhr generated, compared to 75.2 gal in 1954.

Flying hot-air engine

Philips Works of Eindhoven, Holland has an agreement with General Motors Corp to allow GM to use the Philips' hot-air engine, possibly for missiles and rockets. The 1-cylinder piston engine will be an energy source for artificial moons (satellites). Powered by solar energy, the engine is lighter than electrical batteries that might be used and has a much longer life. (*McGraw-Hill World News*)

Computer standards projected

Standards work for numerical control of machine-tool and process-control computers will begin later this year, pending approval by the American Standards Assn. Sponsored by the Electronic Industries Assn, the project aims at solving problems relating to electrical characteristics of data transmission and input-output media such as punched cards, punched-paper and magnetic tape.

What, no chimney?

The newly developed low-cost type-L low-temperature vent may soon see service with new forced- or induced-draft oil home-heating equipment. The National Oil Fuel Institute, National Fire Protection Assn and the Underwriters Laboratories approve its use—in principle. Standard masonry chimneys will no longer be needed if the new vent works out. The L-type vent is a double-walled tube about 4 in. in diameter, similar to the B-vent for gas except that its inner lining is of higher quality. Special tests to be run by the Laboratories deliberately distort adjustment of fuel and air flow; flue temperatures above 550 F at steady state will not be allowed. Temperatures must not exceed 700 F during a 10-min test under abnormal conditions, such as brought about by adding soot burnout compound.

Stirling engine due for comeback?

Thermal engines like the Stirling are under intensive study for widely varying applications—outboard motors, infrared-cell coolers, air conditioners and irrigation pumps. So comments Dr T Finkelstein in an article in the *Battelle Technical Review*. This study ties in with the search for engines using solar- and nuclear-energy sources. Nuclear source would be decay heat of isotopes, while solar energy could be beamed into the working fluid through a quartz window. The engines can work as prime movers, refrigerators or heat pumps. They might use bottled gas for fuel when working as outboard motors, and so offer the big advantage of silent operation.

Thermionic advance

Thompson Ramo Wooldridge Inc report that their subcontractor, Thermo Electron Engineering Corp, has produced a thermionic converter that generates 200 watts at an actual efficiency of 13%. Electron bombardment heats the converter. This is the high-

this month's power-field happenings

B G A SKROTZKI, Associate Editor

est output to date for a practical converter that can be used with a solar concentrator in a working space power system. Concurrently, TRW's Tapco Labs developed a solar concentrator, 5-ft dia, which boasts surface reflectivity up to 92%.

Record hydro units

The Bureau of Reclamation is considering 300-mw turbine-generators (world's largest) for a proposed third powerhouse at Grand Coulee Dam on the Columbia River. If Congress votes funds for it, the Bureau plans to begin a feasibility study in July. Initial installation might be 600 mw. Generators now running at Grand Coulee are rated 108 mw each, with total plant at about 2000 mw. (*McGraw-Hill World News*)

Our 50 states employ 28,000 engineers

National Science Foundation study shows that state agencies had about 88,000 engineers, technicians and scientists on the payroll in January 1959. These are about 10% of all state employees. Of the 28,000 engineers, nearly 60% held college degrees and 45% were licensed professional engineers.

Reds' high-voltage line

The U.S.S.R. has drawn up preliminary plans for a dc-transmission line to run at 1500 kv between the Urals and hydroelectric plants being built in Siberia, about 1500 miles' distance. Reds expect this to cut costs one-third and reduce energy losses. Problems are being studied in the Leningrad Alternating Current Institute, where they're using a 1300-kv unit to test equipment for a 800-kv-dc line that will link Stalingrad and the Don Basin. (*McGraw-Hill World News*)

Liquefied petroleum gas—now

The world's first plant for delivering refrigerated liquefied petroleum gas (LPG) to tankers is now abuilding in Ras Tanura, Saudi Arabia. The $7-million plant, which belongs to the Arabian American Oil Company, will supply 4000 barrels daily of high-purity propane and butane. Three 70,000-bbl tanks will be held at –43 F for propane and 0 F for butane while ambient soars as high as 120 F. The tanks' piping and equipment are lagged with Foamglas, made by the Pittsburgh Corning Corp—a high-strength glass foam with minute sealed cells. Liquefied at 250 psi for propane and 100 psi for butane, the gas is vaporized and then condensed by water cooling. Flash towers and condensers in series deliver the gas to the storage tanks. The low temperatures are held by recirculating vapors back through compressors, towers and condensers. Refrigerated tankers are expected to deliver the gas world wide, starting late this year.

Largest single-shaft unit

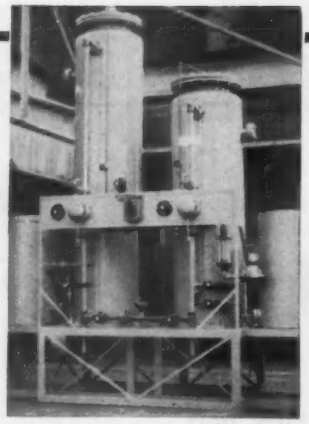
World's first order for 500-mw single-shaft steam-turbine-generators has been placed with English Electric Corporation. Britain's Central Electricity Generating Board ordered the units. Four of them will be built for installation in a 2000-mw plant at West Burton in Nottinghamshire near the East Midland coalfields. First unit will start in 1965 and the plant is scheduled to be completed by '67.

Record fire toll

The National Fire Protection Association reports that U.S. and Canadian industry lost $87.8-million worth of plant in 133 "large-loss" fires during 1960. This was 20 fires and $29.5-million more than in 1959. Industrial fires of all sizes in the two nations take an average annual toll of over $210 million. Cost of all large-loss fires in North America reached $365 million in 1960. In almost all cases, NFPA points out, these record fires started as minor outbreaks. But, because of construction weaknesses or lack of protection, they got out of control.

Controlled-environment program moves

The American Society of Heating, Refrigerating and Air-Conditioning Engineers is transferring its controlled-environment program to the Kansas State Environmental Research Center of the Kansas State University of Agriculture and Applied Science at Manhattan, Kan. The ASHRAE's controlled-environment room will move to the University this summer. The Society anticipates that much of the future research it will sponsor will be of the applied rather than basic type and more closely related to industry problems. The University has established its center to (1) conduct research in human response to thermal environment as it affects health, comfort, learning and productivity (2) conduct research on air-pollution problems (3) collect and disseminate data on man and his environment (4) provide an educational program at the graduate level in environmental engineering.



NEW FROM H&T

Low-Cost • High-Performance

"PACKAGE" DEMINERALIZERS!

TWO-BED and UN-A-BED STANDARD UNITS

NOW AVAILABLE!!

Unless *special* conditions require you to use a *special* demineralizing system, you can save big money—and get excellent results—with the new H&T Standard "PACKAGE" DEMINERALIZER! Into these superior Standard Units, we've put the experience of 16 years in building many hundreds of manual and automatic demineralizing systems. *Result:* H&T "PACKAGE" DEMINERALIZERS are masterpieces of design and construction—unequalled in performance and wonderfully low in cost.

Write for details of Two-Bed and Un-A-Bed Demineralizers

H&T SERVICE

HUNGERFORD & TERRY, INC.

CLAYTON 3, NEW JERSEY

For more facts circle 300 on Reader Service card, p 101

Get yourself a pat on the back

How? By reducing boiler blowdown through accurate continuous control . . . By reclaiming over 85% of the heat from that blowdown . . . By installing the system that needs no maintenance, shows the savings on a thermometer panel, needs less than three square feet of floor space . . . By installing a Madden Continuous Blowdown and Heat Recovery System. To get all the facts write for a copy of Bulletin 150. *The Madden Corporation, 1345 Jarvis Ave., Chicago 26, Ill.*

circle 301 on Reader Service card, p 101

TO FABRICATE STAINLESS WELD IT WITH AIRCO-MATIC

AIRCOMATIC® welding is the lower cost way to fabricate. Weldments show excellent ductility, tensile, and impact properties. Tailored to the process, Airco's wide range of Aircomatic stainless wires can be used for welding all standard alloy types. Remember: Only Airco makes everything you need for stainless welding.

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circle 302 on Reader Service card, p 101

Calendar

July 18-20 — Western Plant Maintenance & Engineering Show & Conference, Pan Pacific Auditorium, Los Angeles, Calif. Details: Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Aug 21-31—United Nations Conference on New Sources of Energy, Food and Agriculture Organization headquarters, Rome, Italy. Details: A G Katzin, Office of Public Information, United Nations, N. Y.

Aug 23-25 — 4th Biennial Gas Dynamics Symposium, sponsored by American Rocket Society and Northwestern U, at Northwestern. Details: Mechanical Engineering Dept, Northwestern U, Evanston, Ill.

Aug 28-Sept 1 — International Heat Transfer Conference, U of Col., Boulder, Col. Details: ASME, Meetings Dept, 29 W 39th St, New York 18, N. Y.

Aug 30-Sept 1—American Institute of Mining, Metallurgical and Petroleum Engineers, 3rd Annual Semiconductor Conference, Ambassador Hotel, Los Angeles, Calif. Details: AIME, 29 W 39th St, New York 18, N. Y.

Sept 3-8 — American Chemical Society, National Meeting, Chicago, Ill. Details: R Avery, ACS, 2 Park Ave, New York 16, N. Y.

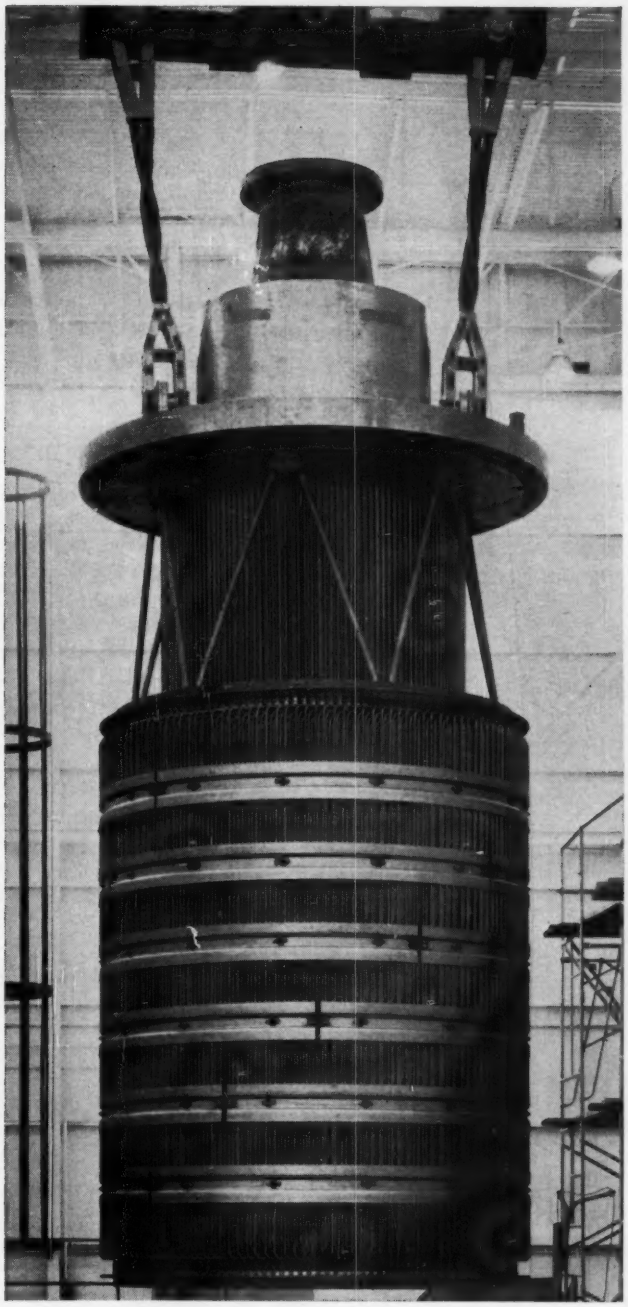
Sept 6-8—Joint Nuclear Instrumentation Symposium, sponsored by ISA, AIEE, IRE, N. C. State College, Raleigh, N. C. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

Sept 11-15—Instrument Society of America, Fall Instrument-Automation Conference & Exhibit, 16th Annual Meeting, Memorial Sports Arena, Los Angeles, Calif. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

Sept 14-15 — Engineering Management Conference, American Society of Mechanical Engineers, American Institute of Electrical Engineers, Hotel Roosevelt, New York, N. Y. Details: ASME, 29 W 39th St, New York 18, N. Y.

continued

TOMORROW'S POWER



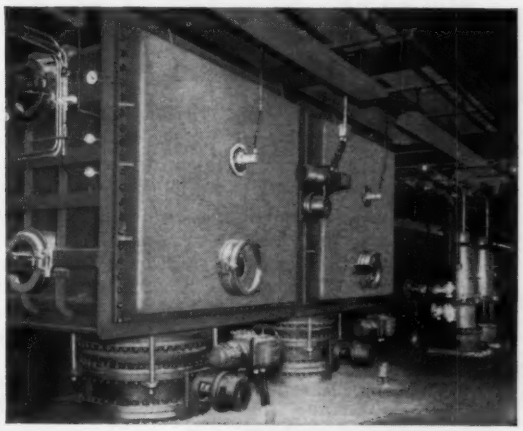
and

C. H. WHEELER / GRISCOM-RUSSELL

COMBINED INGENUITY

AND SKILL BUILT IT.

Three identical Griscom-Russell Vertical Once-Through Involute Tube, Liquid Sodium Heated Steam Generators (one of which is shown here)—have been installed and are being tested at the Enrico Fermi Power Plant built by the Power Reactor Development Corporation. These generators—first of their kind ever built—are an important break-through in the continuing efforts to produce steam from nuclear power more economically.



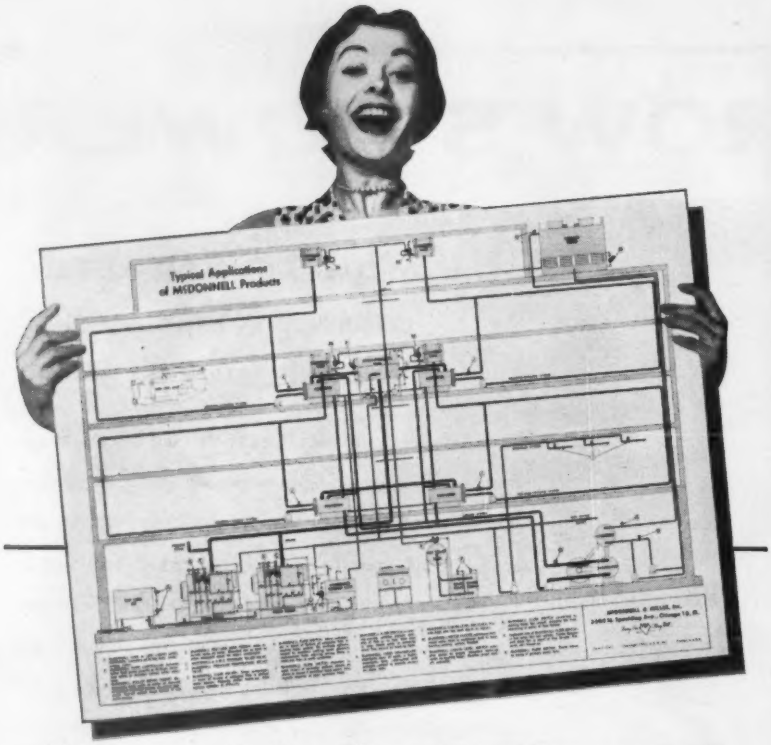
This 50,000 sq. ft. C. H. Wheeler Condenser at the new Indian River Plant of the Orlando (Florida) Utilities Commission, serves the 78,500 (rated capacity) turbine-generator. Its special deaerating features saved money in installation costs. C. H. Wheeler Ejectors, Circulators and the Condensate Pumps shown at the right also serve this new plant.

GRISCOM-RUSSELL / **C. H. WHEELER**

Massillon, Ohio — Philadelphia 32, Pa.

From this combined source you may now select condensers, circulating, condensate and general service pumps, steam jet ejectors, feedwater heaters, evaporators, generator gas coolers, tank heaters, heat exchangers, or special steam generators . . . all engineered and coordinated to meet the performance and space requirements of your power station.

For more facts circle 303 on Reader Service card, p 101



Your kind of Pin-up!

It shows where and why you use McDonnell products

Here is a wall chart that does an excellent job of pointing out the application of McDonnell controls in a typical commercial building.

It's yours for the asking. The gal isn't included; her only purpose is to show you that it is a big, three-foot-wide, easy-to-read chart, printed in four colors to illustrate the applications on boilers, tanks, heaters, chillers, fan coils, cooling towers and other equipment.

Uses of major McDonnell products are shown and described: boiler water feeders, pump controllers, tank feeders, relief valves, liquid level switches, and flow switches.

Unless we're both lucky you won't find all of these uses in any one building. But you'll find many of them—probably more than you'd think—in most buildings. Just mail the coupon to receive your chart by return mail.

McDONNELL & MILLER, *Inc.* 3506 N. Spaulding Ave., Chicago 18, Illinois

Doing One Thing Well

McDONNELL

Boiler Water Feeders • Low Water Fuel Cut-Offs • Pump Controllers • Relief Valves • Flow Switches • Liquid Level Controls for Tanks, Stills, Air Conditioning Systems

Coupon Brings it! (Chart F-1060)

Company Name _____

Street Address _____

City, Zone & State _____

By _____

Mail to: McDonnell & Miller, Inc. 3506 N. Spaulding Ave., Chicago 18, Illinois.

Calendar

Begins on page 164

Sept 21-22 — Industrial Electronics Symposium, sponsored by AIEE, IRE, ISA, Bradford Hotel, Boston, Mass. Details: AIEE, 33 W 39th St, New York 18, N. Y.

Sept 24-27—American Institute of Chemical Engineers, Meeting, Lake Placid Club, Lake Placid, N. Y. Details: AIChE, 25 W 45th St, New York 36, N. Y.

Sept 24-29—Illuminating Engineering Society, National Conference, Chase Park Plaza Hotel, St. Louis, Mo. Details: A D Hinckley, IES, 1860 Broadway, New York 23, N. Y.

Sept 25-28—Industrial Building Exposition & Congress, New York Coliseum. Details: Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Oct 1-5—Electrochemical Society, Inc, Meeting, Statler Hotel, Detroit, Mich. Details: Electrochemical Society, Inc, 1860 Broadway, New York 23, N. Y.

Oct 3-6—9th Annual Human Engineering Institute, Stamford, Conn. Details: Dunlap and Associates, Inc, 429 Atlantic St, Stamford, Conn.

Oct 10-12—Oak Ridge National Laboratory, Nuclear Reactor Chemistry and Analytical Chemistry in Nuclear Reactor Technology Conferences, Gatlinburg, Tenn. Details: Oak Ridge National Lab, P O Box X, Oak Ridge, Tenn.

Oct 17-19—American Society of Lubrication Engineers, 8th Joint Lubrication Conference, Hotel Morrison, Chicago. Details: ASLE, 5 N Wabash Ave, Chicago 2, Ill.

Oct 19-20—National Conference on Industrial Hydraulics, sponsored by Ill. Inst of Technology, Armour Research Foundation, Sherman Hotel, Chicago. Details: J Stathas, Ill. Inst of Technology, 35 W 33rd St, Technology Center, Chicago 16, Ill.

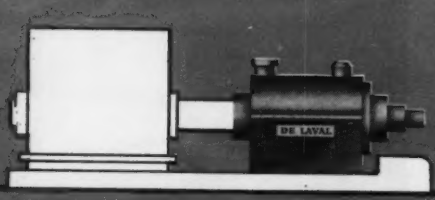
For more facts circle 304 on Reader Service card, p 101

Circle 305 on Reader Service card, for this ad ➤

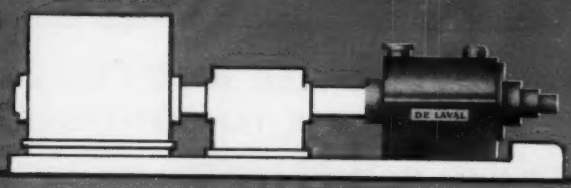
DE LAVAL
BOILER FEED PUMPS

Proven Design Flexibility and Experience

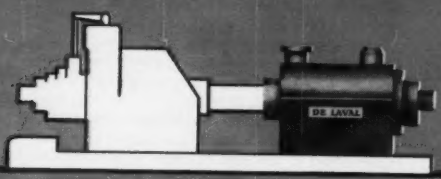
Direct Motor Drive
Atlantic City Electric Co.
2000 HP 125 MW



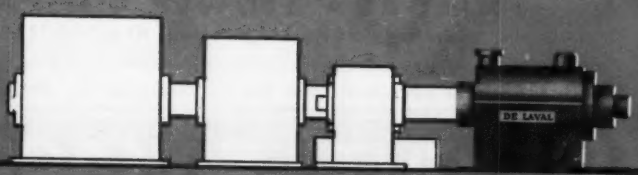
Motor-Hydraulic Coupling Drive
Commonwealth Edison Co.
5000 HP 325 MW



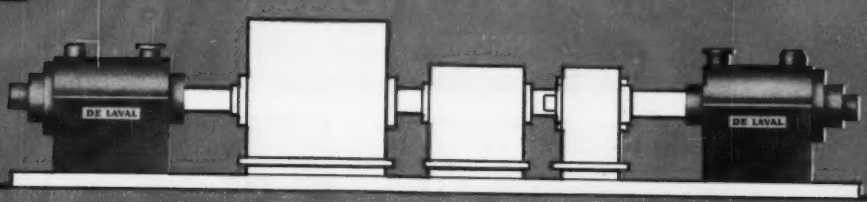
Turbine Drive
United States Steel Corporation
1400 HP 44 MW



Motor-Magnetic Coupling—Gear Drive
South Carolina Electric & Gas Co.
2500 HP 5100 RPM 125 MW



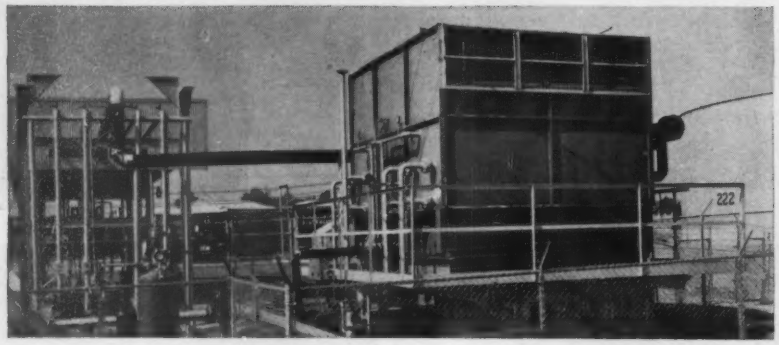
Supercritical Cycle
American Electric Power System
4000 HP 6500 RPM 5500 PSIG 120 MW



Main Generator-Shaft Drive
Commonwealth Edison Co.
4900 HP 325 MW
(FUTURE UNIT)

Main Turbine-Shaft Drive
Pacific Gas & Electric Co.
5250 HP 330 MW

DE LAVAL STEAM TURBINE COMPANY
815 NOTTINGHAM WAY, TRENTON 2, N. J.



SAVE POWER AND COOLING WATER USING AIR TO CONDENSE VAPORS

NIAGARA *AERO* VAPOR CONDENSERS give sustained full capacity in condensing vapors by evaporative cooling with only nominal use of water. You have no problem of water availability, or disposal, or quality, or temperature.

The system is self-contained... no cooling tower or spray pond is required. You save not only the cost of condensing water but also the expenses of piping and pumping, and the cost of water handling equipment.

In the Niagara Vapor Condenser the heat is removed at the rate of input and the cooling effect, directly proportional to the load, is controlled by varying the amount of air passing over the cooling surfaces. Operation is automatic and trustworthy.

Liquids and vapors are always held at constant temperature under close control. You get uniform distillation products the year round. You get better quality and increased production.

Non-condensibles are effectively separated and sub-cooled, giving you better vacuum pump operation. You save power and steam.

Niagara *Aero* Vapor Condensers are manufactured in standard units in a range of capacities up to thirty million BTU's. Write for full information; ask for Bulletin 139-R.

NIAGARA BLOWER COMPANY

Dept. P-7, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U.S. and Canada

For more facts circle 306 on Reader Service card, p 101

CUT LEAKAGE 66% OR MORE!

At High Pressures and High and Low Temperatures...

Here's a low cost, lightweight valve that cuts leakage to 1/5 or 1/3 of standard leak factors for metal seat valves. Assures reduced leakage at pressures as high as 6 000 psi with drops to 1200 psi, and temperatures from −300°F to +1500°F! Ideal for controlling fluids not compatible with rubber. Available in 4" to 72" sizes with manual or power operator and in any castable alloy.

FISHER-CONTINENTAL

PISTON RING BUTTERFLY VALVE

WRITE TODAY FOR BULLETIN 82

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario

Rochester, England

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIP. CO., CORAOPOLIS, PA.

FISHER Controls

For more facts circle 307 on Reader Service card, p 101

Bookshelf

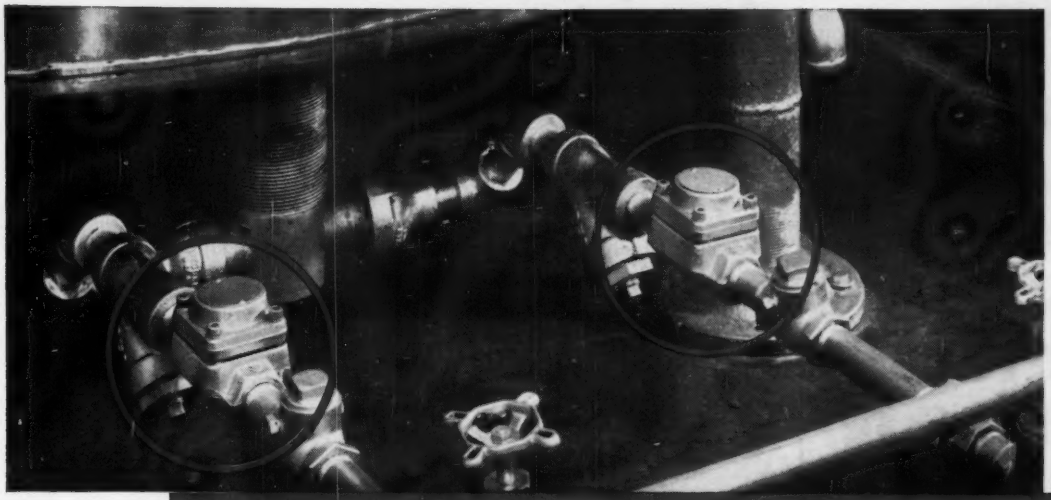
The Dynamic Behavior of Thermoelectric Devices. *By P E Garay, Electrical Engineering Dept, Mass. Inst of Technology, 136 pp, illust, cloth, $3.50. Copublished by The Technology Press, MIT and John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y.*

This first-published report investigates the small-signal dynamic behavior of thermoelectric devices. Book treats linear models that describe small-signal dynamic behavior. Analysis of these models produces a number of small-signal transfer functions that can be used either to compute the response of devices in the frequency domain or to calculate the response of devices in the time domain. They can be used to evaluate quantitative effect of the materials and device parameters on dynamic behavior. This monograph is varityped but reproduction is excellent.

Handbook of Instrumentation and Controls. *By H P Kallen, partner, Kallen & Lamelson. 692 pp, 6 x 9, 550 illust, tables, charts and graphs, cloth, $15.00. McGraw-Hill Book Company, 330 W 42nd St, New York 36, N.Y.*

Plan of this book: help the reader decide how to select and apply instruments and control systems for mechanical services in commercial and industrial buildings and power plants. Ranging from basics to descriptions of complete control systems, this practical manual gives information on how to procure, specify or design equipment for heating, air-conditioning and ventilation systems, diesel plants, refrigeration, water treatment. It covers instrumentation for pressure, temperature, flow, liquid level, pH and conductivity.

Of particular interest is the presentation of control systems illustrating modern practice in the field. Specialized phases, including boiler and combustion controls, boiler flame-failure safeguards and the fundamentals of instrument-system design are covered. Discussion includes such newer developments as control systems for high-pressure steam power plants and controls for large central air-conditioning systems.



Yarway Series 40 Impulse Steam Traps on stainless steel cooking kettles

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

Lady's Choice Foods plant superintendent, Jack McFeron, checks valve on return line from Yarway traps

WHAT'S COOKING?

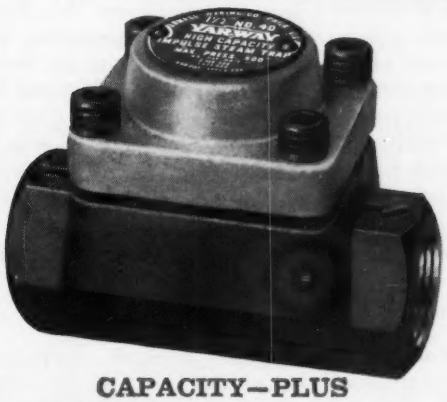
More than 3 times as much production with Yarway Impulse Steam Traps

Main objective of a recent modernization program at Lady's Choice Foods, San Leandro, Calif. was more production—and they got it!

One vital modernization step was the selection of Yarway Series 40 Impulse Steam Traps as a replacement of the old style steam traps formerly used. These Yarway Series 40 traps, designed especially for high capacity applications like the cooking kettles in this plant, were selected for (1) their effectiveness and (2) their small size which enabled them to fit into the new compact piping layout.

Results? Lady's Choice Foods has increased production from 2 batches a day to 7 batches a day.

Can Yarway Impulse Steam Traps help you "cook up" more production and profits? Find out by letting a Yarway Engineer check your steam trapping. Write Yarway now. While you're about it, ask for Bulletin T-1743.



CAPACITY—PLUS

Yarway Series 40 traps feature not only high capacity, but also *high temperature discharge characteristics, excellent low pressure operation, no airbinding, operation against back pressures up to 40%, stainless steel construction.*

YARWAY OFFERS IMPULSE STEAM TRAPS FOR THESE SPECIFIC OPERATING CONDITIONS

AVERAGE CONDENSATE LOADS	EXTRA HEAVY CONDENSATE LOADS	LIGHT CONDENSATE LOADS
Series 60	Series 40	No. 30

For more facts circle 308 on Reader Service card, p 101

ILLCO-WAY DESIGNERS AND BUILDERS
MODERN EQUIPMENT FOR ionXchange
AT 3 PLANTS OF
DETROIT EDISON

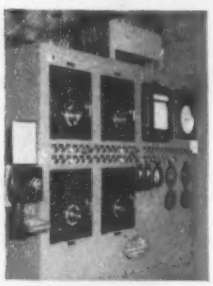
Four IWT installations, the first having been put in 7 years ago, are located in power plants of the Detroit Edison Co., as listed below. The picture at the left shows one of these stations.

RIVER ROUGE POWER PLANT—UNIT NO. 1
Triple Unit Two-Bed De-Ionizers, flow rate 80 gpm *each*, ordered in 1954.

RIVER ROUGE POWER PLANT—UNIT NO. 2
Triple Unit Two-Bed De-Ionizers, flow rate 300 gpm *each*, ordered in 1960.

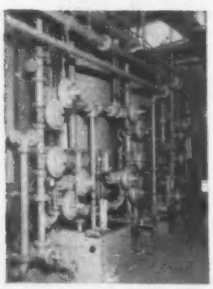
MARYSVILLE POWER PLANT—UNIT NO. 1
Double Unit Two-Bed De-Ionizers, flow rate 170 gpm *each*, ordered in 1957.

DELRAY POWER PLANT—UNIT NO. 2
Double Unit Two-Bed De-Ionizers, flow rate 300 gpm *each*, ordered in 1959.



This picture, taken in the Marysville Power Plant, shows the IWT Control Panel which governs all functions of De-Ionizer regeneration. These control cabinets, which include indicating devices and recording instruments, are designed and built by IWT.

DE-IONIZERS
FOR MAKE-UP WATER



Marysville Power Plant again. This is part of the tanks, piping, power-operated valves, and other elements that are engineered by IWT into a practical, reliable system that delivers high-purity water for high-pressure boiler make-up.

ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

Appointments

Management changes

Charles Concordia

General Electric Company has announced Charles Concordia is now chairman of the study committee on power-system planning and operation of the International Conference on Large Electric Power Systems (CIGRE). He succeeds S B Crary, General Electric Company systems-analysis engineer.

Concordia, with General Electric since 1926, is presently manager of general analytical engineering. He holds six U. S. patents and is author of more than 60 technical papers and a book on synchronous machines. In 1942 he was awarded the General Electric Coffin Award for his work in analysis of wind-tunnel electric drives.

In addition to CIGRE, Concordia is a Fellow of the AIEE, ASME and Senior Member of the IRE.

Richard S Newlin

Anaconda Company's vice-president of Operations, Richard S Newlin, has been appointed chairman of the Uranium Mining and Milling Committee of the Atomic Industrial Forum, Inc. The Forum is the association of the atomic industry; its members range from mining companies, manufacturers, to electric utilities, shipbuilders and universities—all those using nuclear energy.

A P Kibbe, president of Hidden Splendor Mining Company, will assist Newlin as vice-president of the newly organized committee. Seeking solutions to the problems facing the industry, committee will study non-military markets for uranium in U.S. and abroad, accumulate information on non-nuclear uses of uranium and control of possible radiation hazards.

Daniel P Ross

Thompson Ramo Wooldridge Inc announces the promotion of Daniel P Ross to senior engineering specialist in the Tapco Group Research dept.

With the firm since 1954, Ross has been working on the analysis and design requirements of liquid-metal circulating systems, nuclear-power plants, heat transfer, fluid-flow controls, power - conversion - component design and analysis of regenerative fuel cells.

Ross is a member of the American Nuclear Society, Institute of Aerospace Sciences, American Rocket Society and the honorary engineering societies of Tau Beta Pi and Eta Kappa Nu. He is the author of several technical papers.

Engineer changes

Allis-Chalmers Mfg Co: D H Hohnstein, assistant engineer—motor and generator dept; H C Dusek, assistant engineer—thermal power dept; O J Thompson, assistant engineer—nuclear power dept; D J McFarlin, engineering scientist—process and mechanical research. **Consolidated Diesel Electric Corp:** J Greenberg, assistant chief engineer—power equipment div.

General sales managers

Springfield Boiler Co: H G Dean. **Information Systems, Inc,** Panellit Div: A Wombacher. **Thatcher Furnace Co:** J E Price. **Goulds Pumps, Inc:** S A Bunis. **I-T-E Circuit Breaker Co,** Victor Insulators Div: E W Turner, assistant.

Recent moves

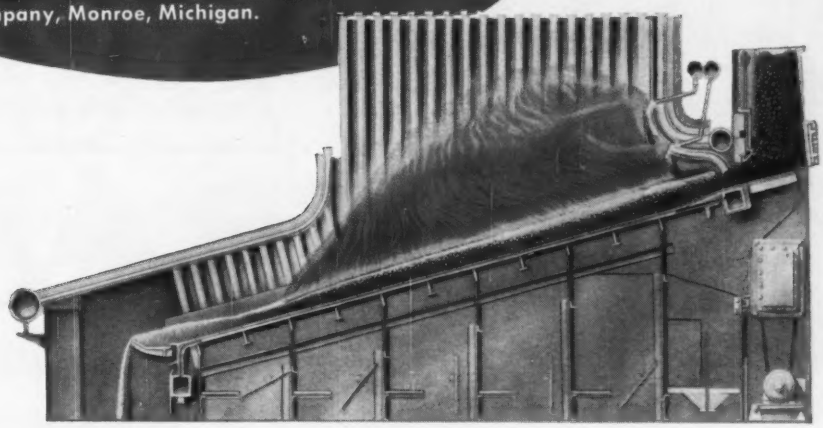
Ultrasonic Industries Inc has relocated at Engineers Hill, Plainview, **N. Y. Fuel Engineering Co** has moved to 215 E 27th St, New York, N. Y. **Ultrasonics Systems Inc** occupies new building at 2255 Carmelina Ave, West Los Angeles, Calif. **Thompson Ramo Wooldridge Computers Co** has moved to 8433 Fallbrook Ave, Canoga Park, Calif., parent company's headquarters.

Expansions

Yardney Electric Corp has purchased Raytheon Co plant in Stonington, Conn. **SKF Industries, Inc** has leased new Asheville, N. C. plant. **Chase Brass & Copper Co,** Div of Kennecott Copper Corp has formed Rhenium Div; J H Port is manager.

now it's DETROIT VIBRA-GRATE STOKER *and* DETROIT-TAYLOR STOKER

Vibra-Grate and Taylor Multiple Retort Stokers formerly manufactured by American Engineering Company of Philadelphia are *now* and will *continue to be* manufactured, sold and serviced by Detroit Stoker Company, Monroe, Michigan.



DETROIT VIBRA-GRATE STOKER

All stoker activities of American Engineering Company, a division of United Industrial Corporation, have been transferred to Detroit Stoker Company, Monroe, Michigan where communications relating to all types of stokers formerly manufactured by American Engineering Company should be directed.

Vibra-Grate and Taylor Stoker users, *present* and *future*, will benefit through:

- **Enlarged engineering and service staffs**
- **Modern manufacturing facilities, centrally located**
- **District sales offices or representatives in more cities**
- **Over 60 years of stoker experience**
- **Continuing research and development programs**

STOKERS FOR BOILERS FROM 3,000 TO 500,000 POUNDS OF STEAM PER HOUR CAPACITY.

DETROIT SINCE 1898 **STOKERS**

DETROIT STOKER COMPANY
DIVISION OF UNITED INDUSTRIAL CORPORATION
MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

For more facts circle 310 on Reader Service card, p 101

for efficiency, specify and use

HOFFMAN

50 SERIES FLOAT & THERMOSTATIC TRAPS

Hoffman F & T Traps give quiet, continuous drainage. For quick access and ease of servicing and repair, all working parts are attached to removable cover . . . no need to break pipe connections.

600 SERIES INVERTED BUCKET TRAPS

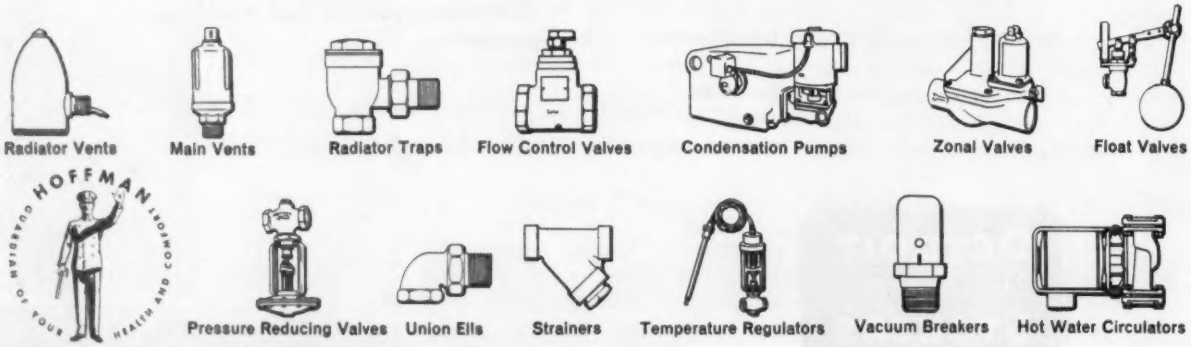
Hoffman Bucket Traps drain intermittently. Featuring stainless steel interiors and straight-through pipe connections. Available with various sized pins and seats for a wide range of pressures.

TRAPS

drain condensate and air from steam lines and equipment

Get maximum efficiency from your equipment and steam lines! Hoffman Traps are precisely engineered to drain condensate and air into return lines. Thus, active steam can continue to circulate and work effectively . . . steam lines and equipment can operate at peak efficiency. Traps shown are just two of the Hoffman Complete Line of quality-tested Steam Traps . . . low, medium and high pressure Thermostatic Traps, Float and Thermostatic Traps, and Inverted Bucket Traps.

HOFFMAN COMPLETE LINE OF SPECIALTIES...STEAM AND WATER



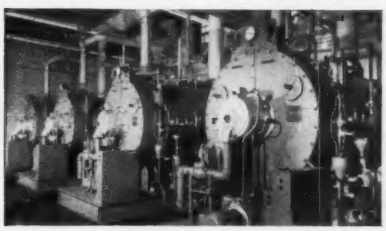
HOFFMAN SPECIALTY MFG. CORP. 1700 W. 10th STREET, INDIANAPOLIS 7, INDIANA

VALVES • TRAPS • PUMPS • STRAINERS • REGULATORS

...a new approach to boiler room profits

If you're faced with the decision whether to buy a new boiler or modernize your old one, consider these two basic facts:

1. Often, boilers can be modernized at a minimum of expense simply by installing a high-efficiency burner.
2. All packaged boilers do not operate with the same efficiency. You can't expect maximum return on your boiler investment if the boiler gives you efficiency only at certain firing rates.



Four completely automatic gas-fired Powermasters *in a large electric appliance plant replace a large coal-fired watertube boiler. Savings of over $10,000 a year are effected just in reduction of man-hours required for attendance. Operating advantages over previous boiler are impressive, with no variation of pressure over widely varying steam demands.*

A truly efficient boiler should operate at the same high efficiency at low capacity as at high or full load. *Powermaster* boilers are the *only* boilers that give you this constant, unchanging efficiency. This is 5 to 1 turndown efficiency. You get the same high efficiency at 20% of capacity as at 100%—and at every load in between, even when loads vary widely! This high efficiency means better boiler performance and impressive fuel savings that will repay the cost of your boiler many, many times in its long and productive life.

Powermaster boilers give you the fastest return on your investment . . . fewer man-hours to operate and maintain . . . more fuel and labor saving features than any packaged boiler on the market.

Need only a high-efficiency burner? O&S Burner Systems with 5 to 1 turndown are available for any make, size or design of boiler, watertube or firetube. Call your nearest O&S representative or write for Bulletin 1260.

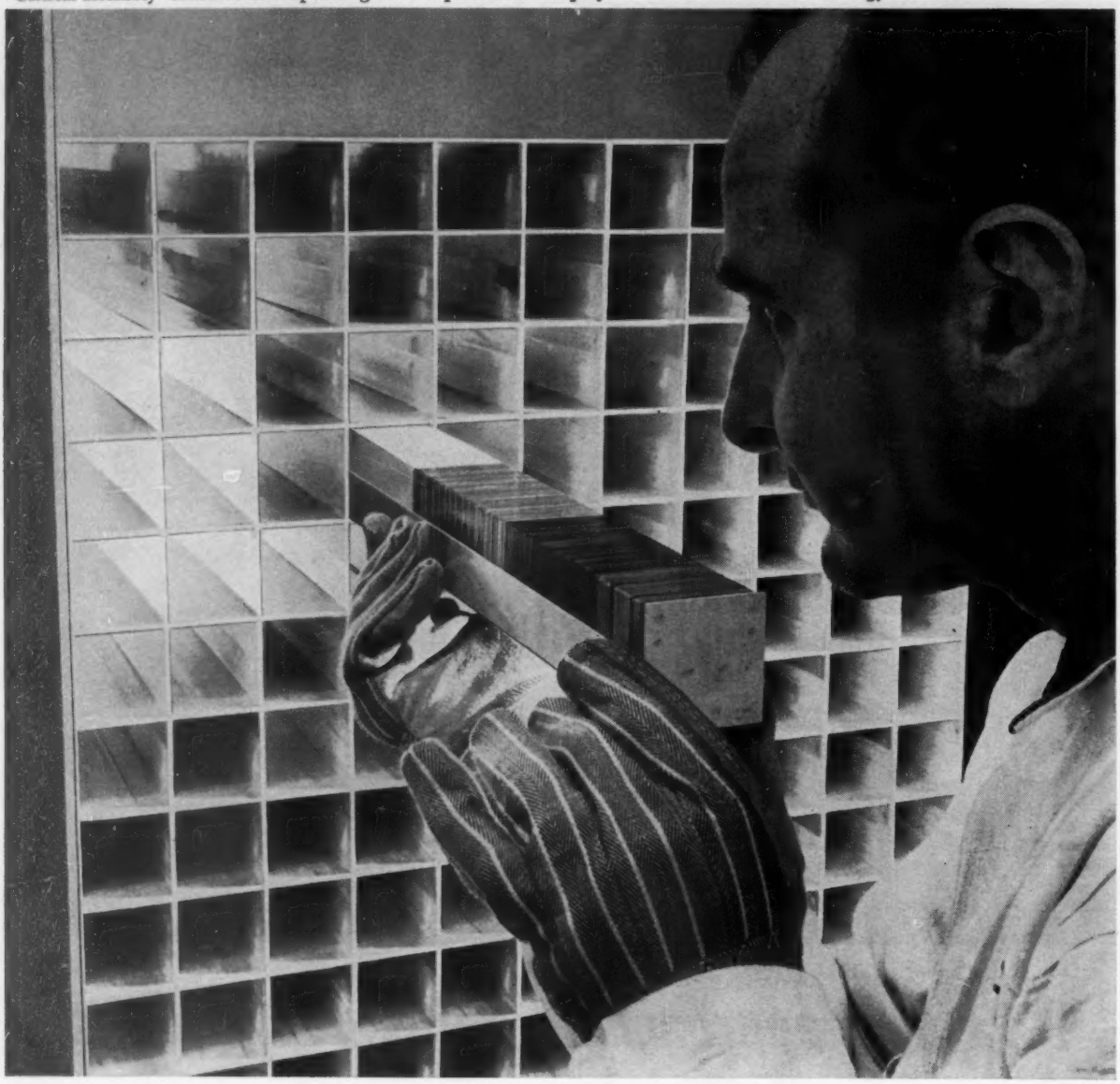
Powermaster®

PACKAGED AUTOMATIC BOILERS

ORR & SEMBOWER, INC.
850 Morgantown Road
Reading, Penna. • Since 1885

For more facts circle 312 on Reader Service card, p 101

"Critical assembly" machine now operating at AI is part of AETR project for Southwest Atomic Energy Associates



The Peaceful Atom

Needed in ten years: 100% increase in world power output

In the dynamic decade ahead, the demand for electrical power will be expanding faster than ever before. To meet this vastly increased need, new and highly advanced concepts are needed. A promising nuclear concept is the Advanced Epithermal Thorium Reactor. The AETR is under active study today by Atomics International for the Southwest Atomic Energy Associates, fifteen investor-owned utility companies. Two other nuclear concepts pioneered by Atomics International are being applied in construction of power stations in Piqua, Ohio, and Hallam, Nebraska, as part of Atomic Energy Commission programs. These are some of the ways AI is helping the power-producing companies of the world double the supply of electricity in the next ten years.

ATOMICS INTERNATIONAL

Division of North American Aviation

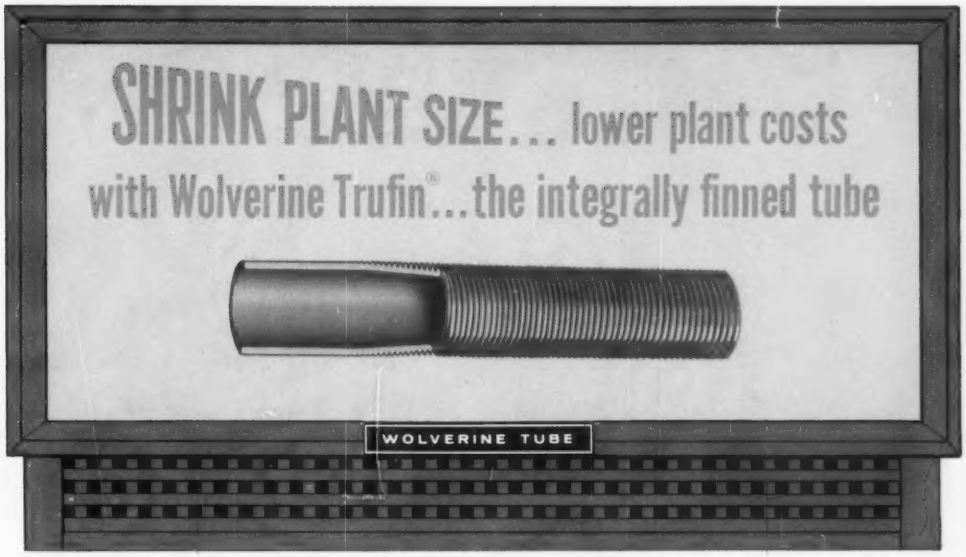
Pioneers in the creative use of the atom

World Headquarters: Canoga Park, California, U.S.A. Cable Address: ATOMICS. *Other Offices:* Washington, D.C., U.S.A.; Geneva, Switzerland. *Affiliated with:* INTERATOM, Bensberg/Cologne, Federal Republic of Germany and DYNATOM, Paris, France

Circle 357 on Reader Service card for Wolverine ad ➤

SIGNS OF THE TIMES

We've designed these little billboards so that they can be easily pushed from the page and assembled for desk-top use. Why not put them together—perhaps their humor will help brighten your day? And remember—Wolverine condenser tube products rate headlines because they do things—the kind of things that make for increased heat transfer efficiency and economy.

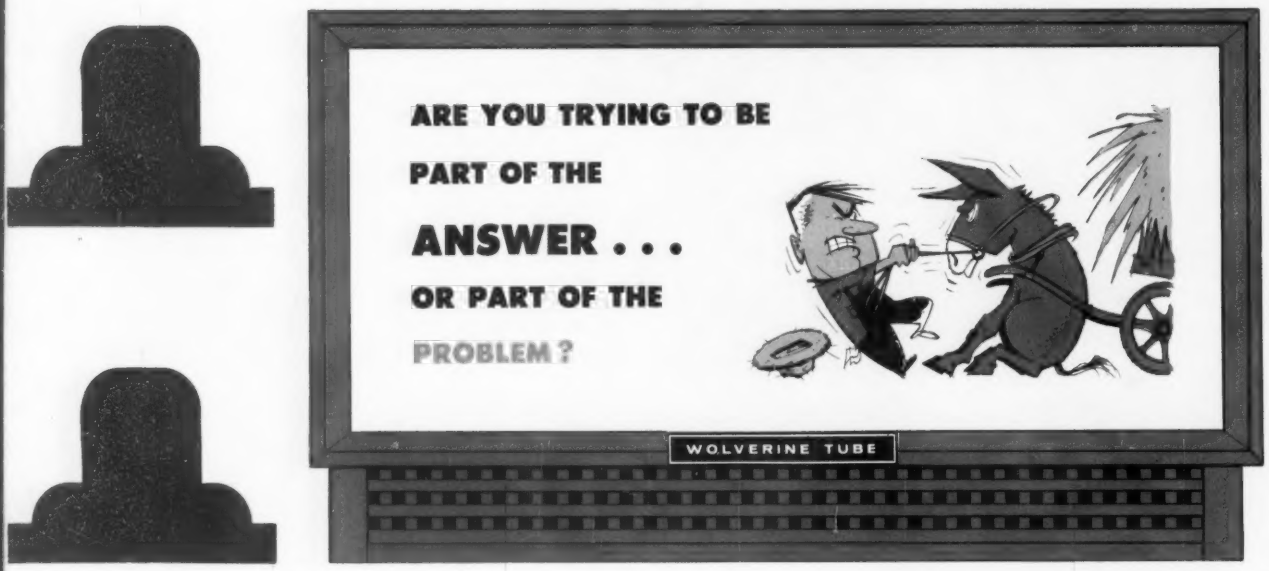


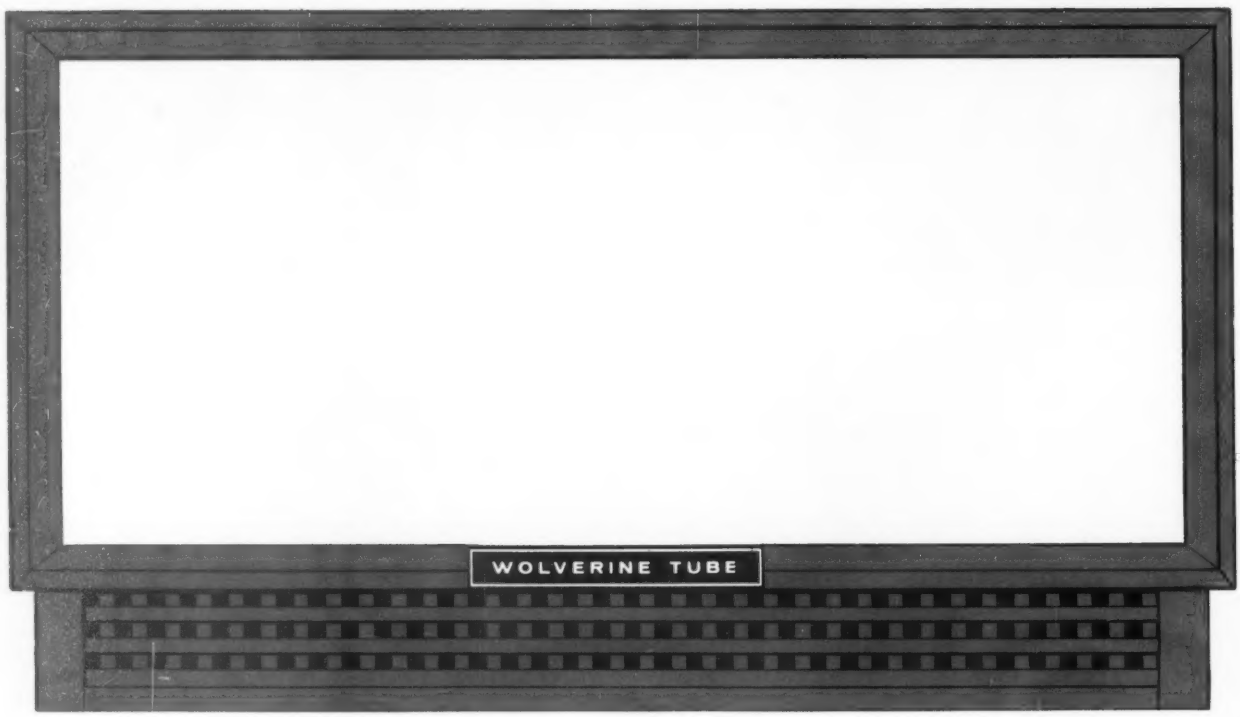
**PUSH OUT PIECES...
SET BILLBOARD IN SLOTS**

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. O, 17268 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

WE'VE LEFT ONE BLANK FOR YOU

fill in your favorite saying and mail it to Wolverine Tube ...help us keep our campaign going





WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. O, 17268 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA • SALES OFFICES IN PRINCIPAL CITIES

Every 7 seconds . . .

Lapsed time between OIC installations is being reduced month by month. More and more maintenance men know they can count on trouble-free operation when they replace worn out valves with OIC. Performance-proven design features include stems made from special OIC Alloy 40 on bronze valves. Result . . . seizing completely eliminated . . . corrosion minimized . . . wear greatly reduced. OIC stems will outlast ordinary valve stems 10 to 20 times. Your local OIC distributor carries a complete line of bronze and iron gates, globes, angles and checks. Call or write today for further information.

BETTER VALVES AND BETTER DISTRIBUTOR SERVICE FROM OIC

someone . . . somewhere . . . installs another OIC valve!

OIC VALVES

BRONZE, IRON, FORGED STEEL, CAST STEEL AND DUCTILE IRON VALVES

INDUSTRIAL DISTRIBUTORS SERVING INDUSTRY ECONOMICALLY THE RIGHT HAND OF PRODUCTION

THE OHIO INJECTOR COMPANY, WADSWORTH, OHIO

THE OHIO INJECTOR COMPANY 10231-OIC

251 Main St., Wadsworth, Ohio

I need more information about OIC bronze and iron valves.

Name_____

Company_____

Street_____

City_____ Zone_____ State_____

For more facts circle 313 on Reader Service card, p 101

Edmund J. Haar, Chief Engineer of Compressor Plant, Thatcher Glass Mfg. Co., Streator, Illinois, and his new FM-2 compressor.

When you bank on compressed air...

Take a look at an operation that *really* depends on air. At Thatcher Glass Manufacturing Co., Streator, Illinois, compressed air plays vital roles. It supplies process air for glass blowing. It powers practically all of their expensive machines and handling equipment. Reliable air pressure is a *must*.

In a recent expansion of its compressed air plant, Thatcher decided on the new Cooper-Bessemer 600 hp FM-2 compressor shown above. This is one of the fine quality M-Line Series featuring "natural force balance" and recognized everywhere for dependable, low-maintenance performance.

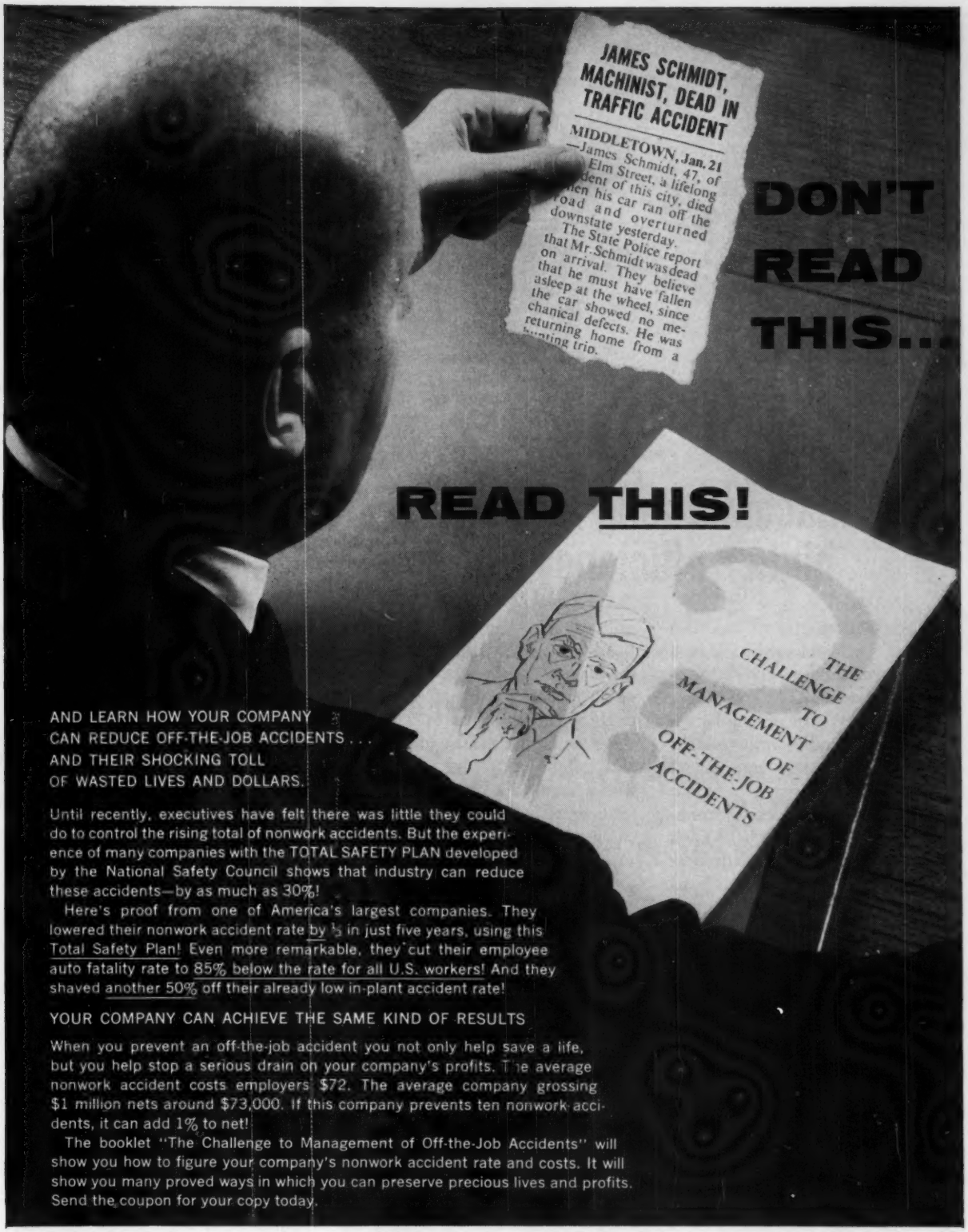
Whatever you make . . . when you want compressed air for processing or power, it will pay you to investigate the Cooper-Bessemer M-Line Compressors. Call our nearest office.

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINES: GAS - DIESEL - GAS-DIESEL
JET-POWERED GAS TURBINES

For more facts circle 314 on Reader Service card, p 101


JAMES SCHMIDT, MACHINIST, DEAD IN TRAFFIC ACCIDENT
MIDDLETOWN, Jan. 21 —James Schmidt, 47, of Elm Street, a lifelong dent of this city, died hen his car ran off the oad and overturned downstate yesterday.
The State Police report that Mr. Schmidt was dead on arrival. They believe that he must have fallen asleep at the wheel, since the car showed no mechanical defects. He was returning home from a hunting trip.
DON'T READ THIS...
READ THIS!
THE CHALLENGE TO MANAGEMENT OF OFF-THE-JOB ACCIDENTS

AND LEARN HOW YOUR COMPANY CAN REDUCE OFF-THE-JOB ACCIDENTS . . . AND THEIR SHOCKING TOLL OF WASTED LIVES AND DOLLARS.

Until recently, executives have felt there was little they could do to control the rising total of nonwork accidents. But the experience of many companies with the TOTAL SAFETY PLAN developed by the National Safety Council shows that industry can reduce these accidents—by as much as 30%!

Here's proof from one of America's largest companies. They lowered their nonwork accident rate by ⅓ in just five years, using this Total Safety Plan! Even more remarkable, they cut their employee auto fatality rate to 85% below the rate for all U.S. workers! And they shaved another 50% off their already low in-plant accident rate!

YOUR COMPANY CAN ACHIEVE THE SAME KIND OF RESULTS

When you prevent an off-the-job accident you not only help save a life, but you help stop a serious drain on your company's profits. The average nonwork accident costs employers $72. The average company grossing $1 million nets around $73,000. If this company prevents ten nonwork accidents, it can add 1% to net!

The booklet "The Challenge to Management of Off-the-Job Accidents" will show you how to figure your company's nonwork accident rate and costs. It will show you many proved ways in which you can preserve precious lives and profits. Send the coupon for your copy today.

Published to save lives in cooperation with The Advertising Council and the National Safety Council

SUPPORT YOUR LOCAL SAFETY ORGANIZATION

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Please send a copy of "The Challenge to Management of Off-the-Job Accidents." I want to learn how my company can save lives and dollars with your TOTAL SAFETY PLAN.

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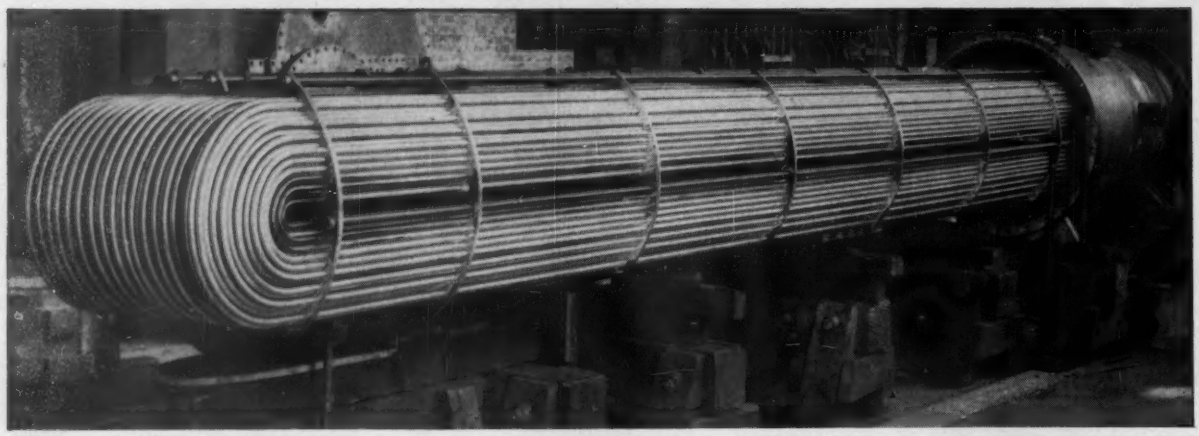
ADDRESS_____

CITY_____ ZONE_____ STATE_____



This typical bundle of long-length Anaconda U-Bend tube is the heart of the modern feedwater heater. To get optimum capacity and efficiency—and a more economical and compact unit—designers have lengthened heaters instead of increasing shell diameter.

IN POWER PLANT FEEDWATER HEATERS

Anaconda long-length U-bend tubes offer higher efficiency and greater economy

Feedwater heaters play an important role in the efficient operation of a steam power station—and with today's more demanding conditions, the trend is to the use of long-length U-bend tube bundles in these higher pressure, higher temperature heat exchangers.

U-bend tube design reduces the number of tube joints to one-half. Each U-bend tube takes care of its own expansion stresses. There's no floating head—one less gasketed joint—all resulting in a more economical, more compact heater.

Now Anaconda makes heat exchanger tubes to 100 feet. This means U-bend tubes with legs approaching 50 feet are available. And the radius of the bend can be as small as 1½ times the diameter of the tube—or as great as 30 inches. Dual-gage tubes are made with extra wall thickness in the area of the bends, to cut cost and weight.

With a large family of alloys available for heat exchanger tubes, Anaconda can meet almost every requirement. From Arsenical Admiralty-439 to the cupro nickel group, long-length U-bend tubes can be made to handle a wide range of temperatures and pressures.

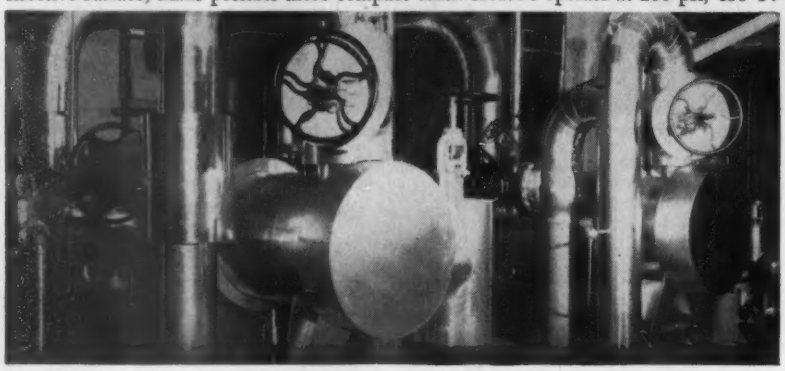
Specialists at Anaconda are constantly working with users and manufacturers of heat exchange equipment, helping to solve individual problems. This experience is available to you. For more detailed information on duplex tubes, dual-gage as well as U-bend tubes, see your Anaconda representative. Or write to: Anaconda American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 6061

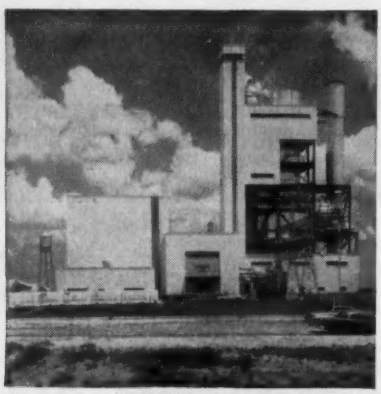
ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Anaconda American Brass Company

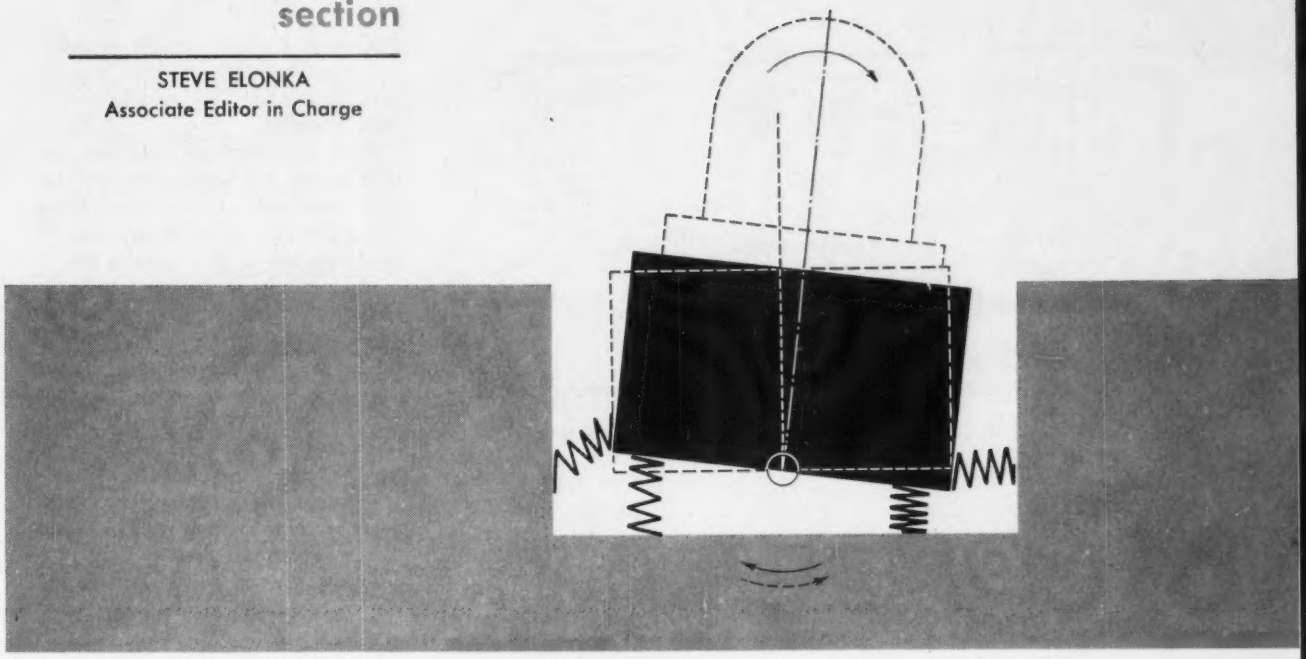
Two of the three feedwater heaters at Nichols Station, using a total of 1692 Anaconda U-bend tubes of Arsenical Admiralty-439. Griscom-Russell Co., Massilon, Ohio, designed and built the heaters. U-bend bundles of longer, smaller diameter tubes provide a more effective surface, make possible more compact units. Heaters operate at 200 psi, 450°F.





The new 112,500-kw Nichols Station of Southwestern Public Service Co., Amarillo, Texas.

STEVE ELONKA
Associate Editor in Charge



Here is your . . .

Practical guide to machine anchoring

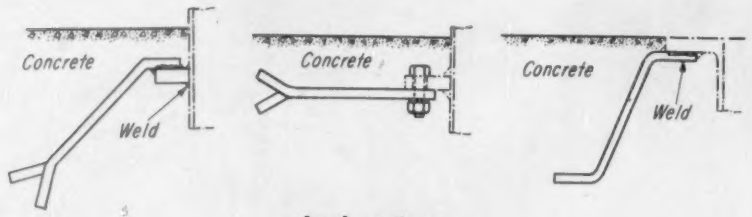
By LOUIS DODGE, New Richmond, Ohio

Precision machinery needs an adequate foundation. If you intend to get out of your machine all the service life and maintenance simplicity the manufacturer built in, be sure it rests upon a foundation equally capable of doing a good job, both statically and dynamically. The foundation often must be tailored not only to suit dynamic forces generated by the machine, but also other sources of vibration in the building that will house the installation, or even the natural frequency of the soil under your plant.

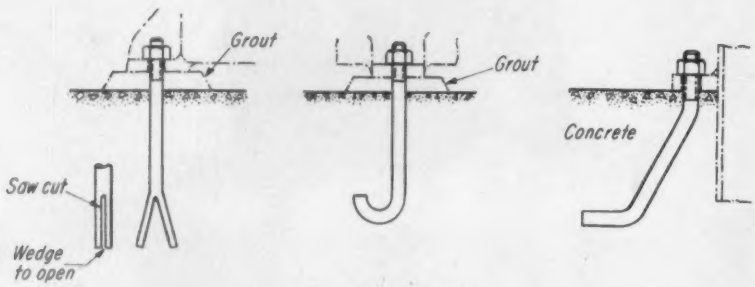
From these complex requirements have sprung many different designs for foundations. Each belongs to one of three main groups. (1) The rigid foundation without means for damping comes in when you have no vibration to speak of. It can be statically determined and is usually small in mass, but it covers a large enough base area to need no insulation. (2) Elastically supported foundation has the job of minimizing vibration or absorbing large shock loads. You need a large mass of reinforced concrete, which should float on an elastic support. This foundation must be isolated from the building or adjoining foundations. (3) In a foundation-without-mass arrangement, machines mount directly on elastic supports. This is most common for small machines running with some dynamic unbalance, where noise must stay low.

continued

SOLID ANCHORING, with base embedded or surfaced,



Anchor straps



Anchor bolts

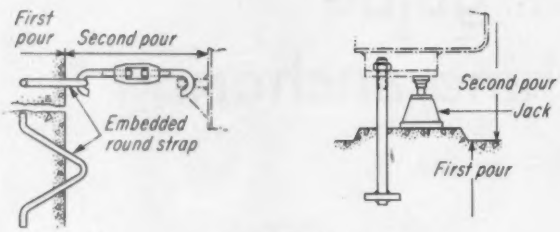
Let's look at some specific engineering practices. One of them may be just the method you need to anchor your machine.

First three sketches show how *anchor straps* are fastened to machine parts embedded in concrete. These straps are all easy to make. Applied as shown, they'll do a reliable job.

Anchor bolts of various types hold down embedded or removable parts. Top end fastens the machine, while the lower end takes one of a number of special shapes to secure the bolt firmly in concrete. Big point to watch here: the bolts must be spaced to fit the machine's base perfectly. There's no margin for error, because once the concrete is poured, your bolts are frozen in place for keeps.

The *spring-rod anchor bolt* is one way of coping with this headache.

MACHINE LEVELING can be done before the final concrete



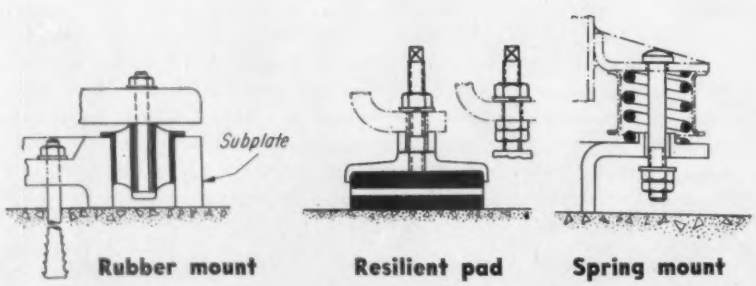
Turnbuckles

Turnbuckle design, far left, helps position the machine, and it preloads the installation before the final pour of concrete. Design at near left is a variation of the same principle; it uses a jack for preloading.

The *leveling screw* at right is an old standby, stepping in where you need to adjust your machines precisely on uneven floors. In recent years, *wedge blocks* have picked up the load where heavy and long machine beds must be kept straight. You can shift these blocks around from machine to machine as you need them.

One thing to keep in mind: These devices are all

VIBRATION ISOLATORS are resilient materials, springs, or



Rubber mount **Resilient pad** **Spring mount**

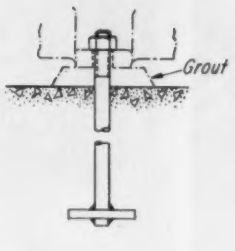
Rubber mounts or cork mounts are available in an almost endless spectrum of varying designs. They are especially effective for small- and medium-sized machinery, where they help reduce noise, shock, stress and strain. *Spring mounts* can be made very soft, and then you can alter the spring tension to suit the load. Bare springs provide the best vibration isolation because they absorb almost no energy; rubber will absorb about

uses grouted studs or easily removable hold-down bolts

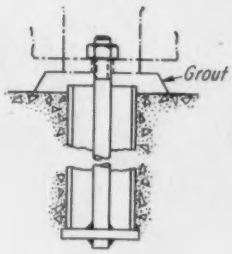
Although you cannot remove this bolt from the foundation, either, its spring permits slight adjustment to suit the machine's position. Another variation is the *removable anchor bolt*—here, the protruding platforms of the foundation should be ribbed.

Embedded base plate is designed to prevent horizontal shift and to anchor the machine firmly at the same time. *Expansion bolts* come into the picture when specs call for mounting machinery on existing foundations or floors. Bolt holes of proper diameter and depth can be drilled and expansion bolts inserted.

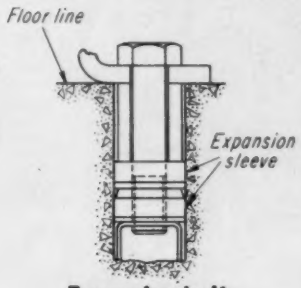
Here's a tip to remember: cleanliness around the foundation is essential. Leaking oil lines, for example, should never be tolerated. Animal fats and vegetable oil will actually disintegrate your concrete.



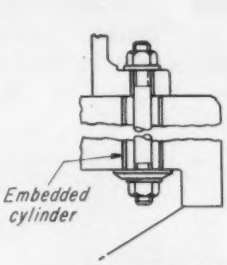
Anchor bolt

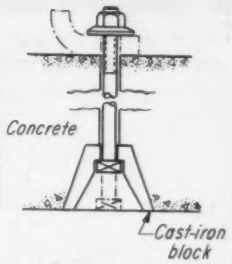


Spring rod

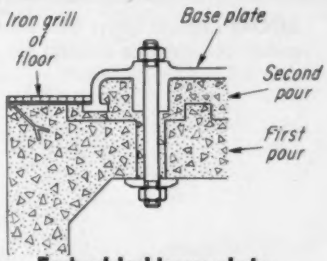


Expansion bolt





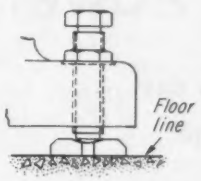
Removable anchor bolts



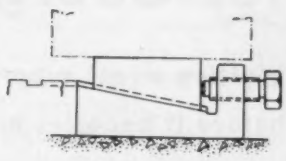
Embedded base plate

pour or anytime after you've set your machine in position

machine positioners. They will not isolate or damp vibration. In order to stop vibration transmission between machines and building structures, and also to make it easier to live with the machine you are anchoring, you may want to consider using vibration isolators under the machine base. POWER's 16-p special report, *Vibration Isolation,* August 1960, goes into more details on the vibration problem and what you can do about it, gives charts to help with your calculations. Now, let's pick up a few pointers on some types of vibration isolators, and see how they should be installed for best service.



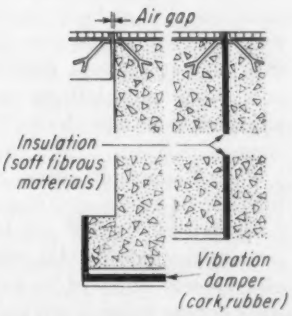
Leveling screw



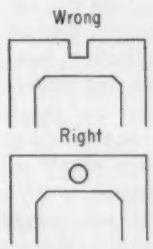
Wedge block

for high-mass machines, isolated bases

27% and natural cork 6 to 11%, in a range of 800 to 2000 fpm. To retain the elasticity of cork and rubber, the static load should not exceed 70 lb per in.—cork will harden under excessive loads. Mounting on *resilient pads* combines several valuable features: the pads absorb shock and vibration; machines can be leveled. To avoid shock transmission, design an *air gap* into your foundation or build in some soft material.



Air gap



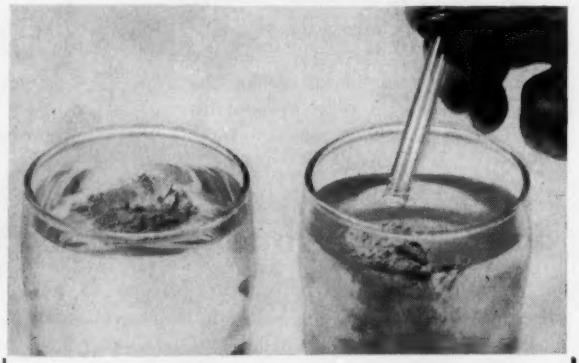
INDENTATIONS and channels should be avoided. Don't let conduits for piping and wiring impair foundation's overall strength

BEFORE chemical sprays were installed, a cloud of coal dust generated by unloading polluted the atmosphere around the plant

AFTER the complete wetting-agent spray system went in, dust just about vanished. This plant uses 120 to 130 tons of coal per hour

No more coal-dust problem for Georgia Power

Wetting agent suppresses dust before it becomes airborne



WETTING AGENT — a single drop — in glass at right precipitates fines immediately. No wetting agent has been placed in glass at left, and here the dust and water don't mix—fines float on top

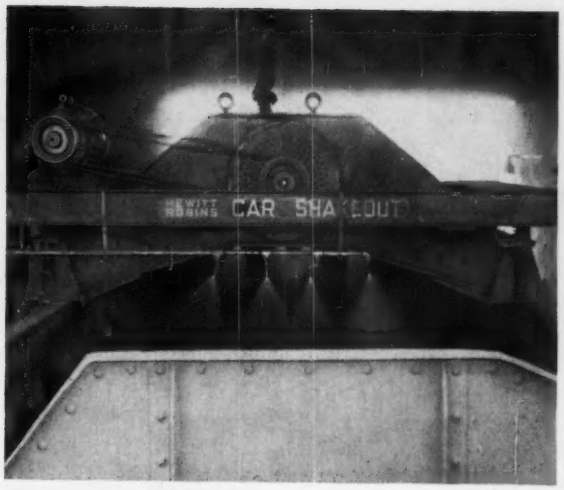
Each year industrial plants invest millions of dollars in dust-collection equipment. Looking for no specific economic return, they are spurred on by their obligation, legal and moral, to the health and welfare of employees, neighbors and nearby communities. But there are some problems that dust collection simply will not solve. A prime example is *mechanical dust*, which in the energy-systems field is usually created in the course of coal-handling operations—car shakeouts, crushing, conveyor discharges and transfer points between conveyors.

Georgia Power Co's 300,000-kw Plant Hammond in Rome, Ga. came up against this coal-dust problem. They solved it with a controlled wetting system that suppresses dust before it gets into the air. Plant Hammond has a high load requiring 120 to 130 tons of coal an hour. Handling this amount of West Kentucky soft coal in an 8-hr shift was a ticklish situation, especially during the peak summer months.

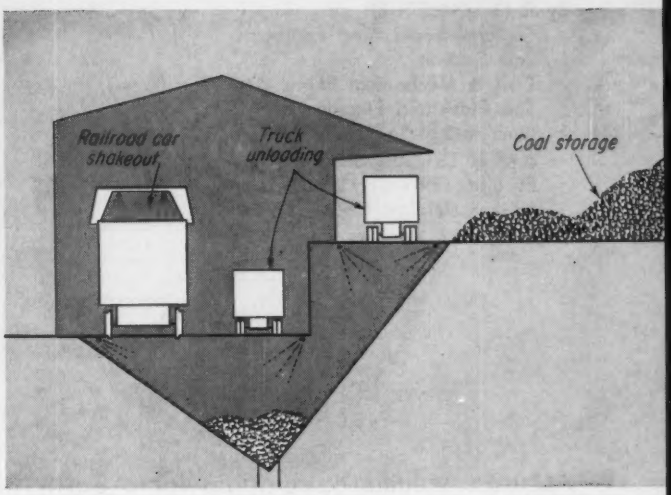
Plant Hammond receives coal both by railroad car and 20-ton bottom-dump trucks. Trucks run back and forth to Guntersville, Ala. where they pick up coal delivered by barge. The track-hopper house is designed to unload trucks and railroad cars simultaneously. And when coal is being reclaimed from the storage pile, it, too, is bulldozed into the track-hopper house.

The dust storm that normal unloading operations can blow up is shown in "before" photo, above left. But applying a chemical dust suppressant during truck and railroad-car unloading went far toward solving the problem, as "after" photo shows.

Let's see how this chemical spray works. Laboratory photo, above, shows that coal dust (and many other fine dusts, as well) won't mix with ordinary water. Instead, the water forms drops that roll off the coal,



SPRAY HEADERS stop most dust before it has a chance to boil up. They're mounted on car shakeout and at top of the track hopper



PROBLEM here is three coals with widely varying moisture content: run-of-mine lump, crushed coal from cars and crushed stored coal

leaving dry surfaces exposed to the air. But water can be treated with a wetting compound, supplied by many chemical firms. In this case, a surface-active agent, supplied by Johnson-March Corporation of Philadelphia, Pa., is used to reduce the water's surface tension enough so the water can penetrate and thoroughly wet the coal dust. Very little moisture is needed—as little as ½ of 1% may do the job. This small amount of moisture has little effect on the heat value or combustion of the coal.

Cost of treatment at Plant Hammond is kept well under 1¢ per ton by carefully proportioning the chemical in relation to quantity of water used. The compound is mixed in a liquid proportioner. A bellows type positive-displacement pump draws wetting agent from a drum and dispenses it into a stainless-steel mixing tank at the ratio of one part compound to 1000 parts water.

Chemical solution is distributed throughout the dust-suppression system by a bronze-fitted centrifugal pump, part of the proportioner. Plant Hammond applies the wetting solution at three major locations: track-hopper house, discharge of the track hopper and crusher house, sketch, above right.

Many power plants have a railroad-car shakeout or rotary car dumps. A few combine their reclaim-hopper entrance with the shakeout. Others have facilities for handling both railroad cars and trucks. But Plant Hammond's combination, handling coal from all three sources, presents some unique headaches.

Moisture content, and therefore dustiness, of the coal varies considerably from one source to another. The rail cars may be bringing in very dry coal while coal from the trucks is quite wet, or vice versa. Coal from the trucks or rail cars is run-of-mine, mostly 2-in. lumps and all below 12-in. Coal from the reclaim pile is another problem entirely, since it has been crushed to ¾- to 1¼-in. size.

Layout of the track hopper permits the generated dust to rise at the inactive dump locations. When rail cars are unloaded, dust boils up out of the truck-dump and reclaim openings. Generally, more dust comes out of the unused positions than from the actual dumping location. Air displaced by the coal rushes out, carrying fine coal particles along with it.

Initial application of the wetting solution is from spray headers mounted on the car shakeout, above, and from below-ground-level sprays around the top of the track hopper. These sprays work to suppress the dust whether the hopper is being filled from rail cars, bottom-dump trucks or the storage pile. Another set of sprays applies solution where hopper discharges to main conveyor.

In the crusher house, sprays are spotted behind the flapper gate and at each end of the skirts from the crusher discharge chute. They coat the newly exposed surfaces. The flapper gate directs crushed coal to the proper conveyor, which delivers it to interior storage bunkers or the storage pile. At the end of each discharge-chute skirt, an over-the-belt control turns sprays on only when coal is on the conveyor. As soon as the load has been crushed, the sprays turn off automatically.

Wetting agent continues to work into the dust until it completely covers all surfaces. Spray is effective for some time, so it's usually not necessary to reapply solution unless a large amount of dry, dusty surface is exposed to the atmosphere.

Lasting effect of the sprays reduces installation cost by eliminating long solution lines to the transfer houses and controls at each transfer point. Plant Hammond has three conveyor transfer points — one between the track hopper and crusher and two between crusher and the interior coal-storage bunkers. But there are no sprays at any of these points. They find that wetting compound applied at the discharge of the track hopper and the crusher is adequate to control dust along the entire length of the conveyors.

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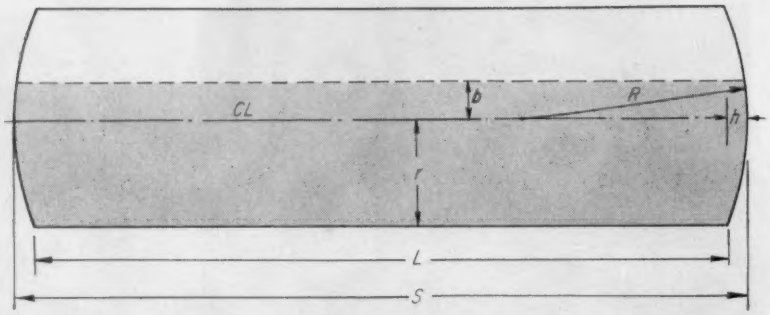


PARTIALLY FILLED TANK with spherical ends represents a tough measuring problem. Dimensions shown above appear as variables in the volume equation at right

Accurate volume calculations for a partly filled tank formerly required approximation methods. But here's a direct solution: Cleveland Electric Illuminating Co's engineers show . . .

How to check volume of liquid in a tank

As Test Section engineers for The Cleveland Electric Illuminating Company, we are responsible for periodically testing the performance of all equipment on the system. In the process of obtaining and evaluating this test data we have come up with several special techniques which we feel could be useful to other operating personnel, both in utility systems and industrial plants. One of these techniques is an accurate and speedier calculation procedure for determining the volume of liquid within a tank of the type shown above. Perhaps our experience can save time and error in your testing program.

ASME Code type test of steam-turbine cycles requires that the cycle be isolated to eliminate unmetered inflow or outflow of steam and water. At our plants, with the unit isolated, water entering or leaving the cycle shows up as a level change in the hot surge tank. Our hot surge tanks are located after the deaerator, and the boiler-feed pumps take their suction from the tanks.

These tanks are horizontal cylinders with spherical ends, as shown above. To detect cycle inflow or outflow, our measurements of the water content of these surge tanks must be accurate. Since the surface area of the water is large, we have to be sure of level change and the correlation between level and volume.

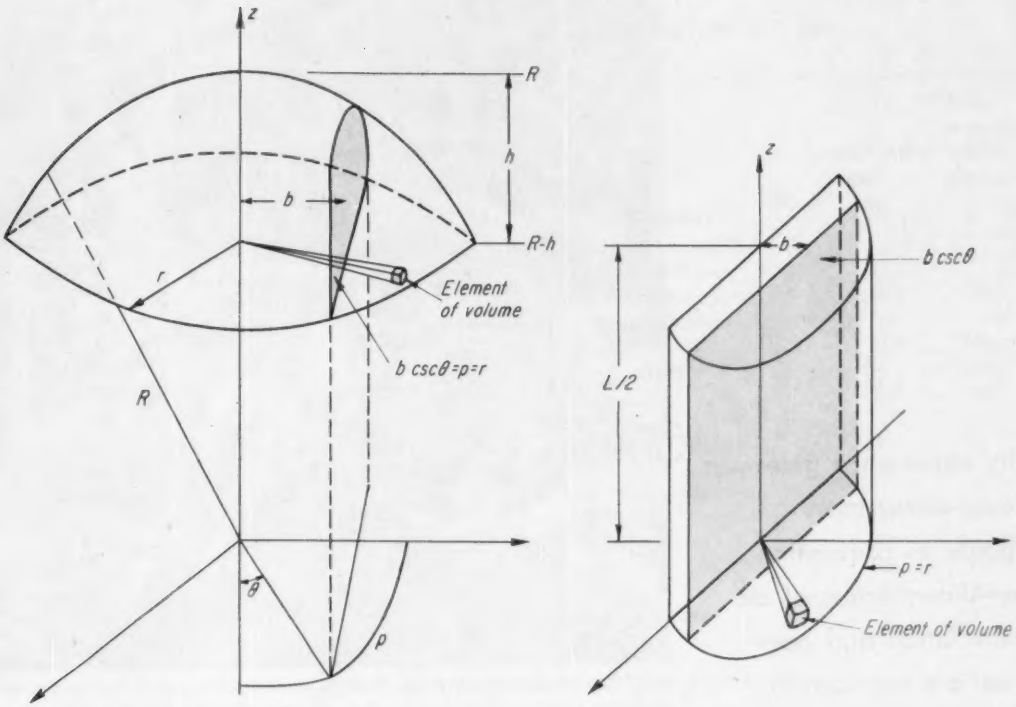
Problem of expressing tank volume as a function of level is relatively simple—if you are willing to ignore the spherical ends. In the past, many engineers have gotten around the difficult calculus problem of handling end volume. They've tried numerical-approximation methods, prepared tables and curves of tank volume vs measured level.

For better evaluations of water volume, taking less time, we derived the set of equations shown at right. This material represents a real breakthrough for us: it eliminates another manual-test data-reduction operation. We find the equation particularly useful since it is compact enough to be included in our turbine-test computer programs. But even without a computer, the increased accuracy of volume calculations should be a big help to any engineer who must measure system content. Our own test results show that values generated from the equation check well within test accuracy limits and differ from our old approximations in the direction and magnitude we expected.

Derivation of our equation is based upon two problems: What is the volume of the entire tank? What is the volume of liquid height in the tank? Our formulas are based on the measurements shown above, where S is the overall tank length, L the length of the cylinder, r the cylinder radius, R the radius of curvature of the tank ends, b the distance from tank center line to liquid level and h, as shown, equals $(S - L)/2$.

Applying this formula requires prior accurate measurement of tank dimensions. These are *inside* tank dimensions, but you can figure them from exterior measurements plus plate-thickness data. As a somewhat less-accurate method, dimensions could be taken from tank-fabrication drawings in your files.

When using the formula for manual calculations and repetitive tests of one system, several preliminary computations may be stored as constants. The drawing above indicates one variable, b, which is a function of tank level. Volume equation at right contains three factors which do not include b. With these precalculated, you are left with two terms, b^2 and $\sin^{-1}(b/r)$, to calculate after each test.



Formula evolves from two separate volume equations

It is hard to set up one equation for the integration. We can handle the problem more easily by breaking it into two parts and adding the results. We will define the spherical volume as V_s, the cylinder as V_c

For the sphere: $p^2 + z^2 = R^2$ and $\theta = \sin^{-1}(b/r)$. Limits are: z from $R - h$ to R, θ from $\sin^{-1}(b/r)$ to $\pi/2$, p from $b \csc \theta$ to $\sqrt{R^2 - z^2}$

$$V_s = 4 \int_{R-h}^{R} \int_{\sin^{-1}(b/r)}^{\pi/2} \int_{b \csc \theta}^{\sqrt{R^2-z^2}} p \, dp \, d\theta \, dz$$

$$V_s = 2 \left\{ \frac{2R^3}{3} \left[\frac{\pi}{2} - \sin^{-1}\left(\frac{b}{r}\right) \right] - \left[R^2(R-h) - \frac{(R-h)^3}{3} \right] \left[\frac{\pi}{2} - \sin^{-1}\left(\frac{b}{r}\right) \right] - b^2 h \cot \left[\sin^{-1}\left(\frac{b}{r}\right) \right] \right\}$$

For the cylinder, limits are: z from 0 to $L/2$, θ same as for sphere, p from $b \csc \theta$ to r

$$V_c = 4 \int_{0}^{L/2} \int_{\sin^{-1}(b/r)}^{\pi/2} \int_{b \csc \theta}^{r} p \, dp \, d\theta \, dz$$

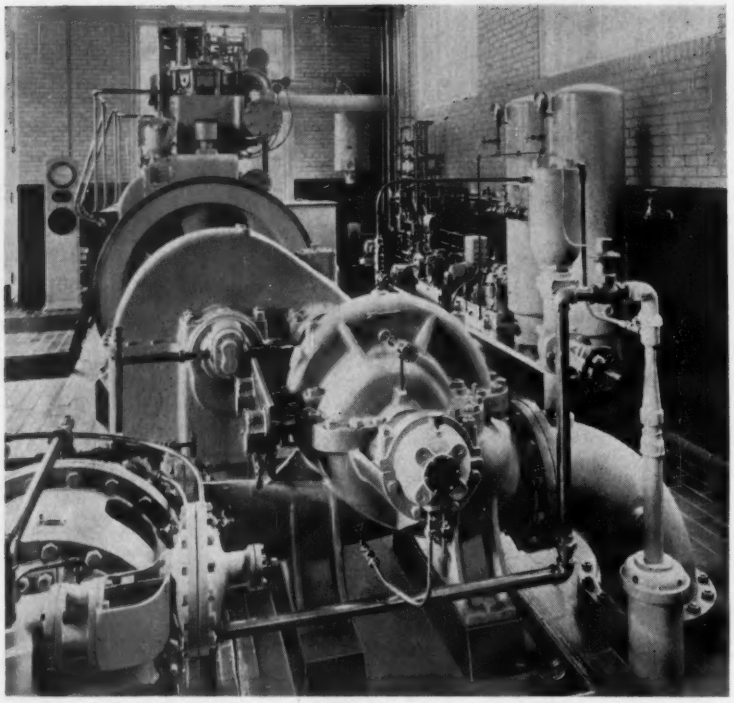
$$V_c = r^2 L \left[\frac{\pi}{2} - \sin^{-1}\left(\frac{b}{r}\right) \right] - b^2 L \cot \left[\sin^{-1}\left(\frac{b}{r}\right) \right]$$

Since $V = V_s + V_c$ we add the two equations and find:

$$V = \left[2h^2 \left(R - \frac{h}{3} \right) + r^2 L \right] \left[\frac{\pi}{2} - \sin^{-1}\left(\frac{b}{r}\right) \right] - b^2 \left(L + 2h \right) \cot \left[\sin^{-1}\left(\frac{b}{r}\right) \right]$$

If the liquid level is below the center line, the equation will give the volume of liquid contained in the tank. But, if the liquid level is above the center line, the equation will give the empty space in the tank. In this case, subtract this volume from known total volume of tank. The limiting case of $b = 0$ will give half the tank volume.

Casualty experience gives centrifugal-pump users a good guide to preventing failures—shows areas of design, installation and operation that are most apt to cause trouble



EMERGENCY SERVICE-WATER PUMPS should be protected by suction strainers. Strainers keep foreign material from getting into the impeller and damaging it

To guard against centrifugal-pump failures, know their primary causes

Probable failure, the sword of Damocles in any centrifugal-pump installation, depends on factors ranging from application and pump type to degree of preventive maintenance. But a statistical review of past failures can guide users by showing them the sensitive areas. Forewarned is forearmed; emphasis on the weak links will go a long way toward catching potentially serious troubles before they get a chance to become actual.

A recent statistical survey of centrifugal-pump failures, made by The Hartford Steam Boiler Inspection and Insurance Company, provides a good basis for users to predict trouble areas and guard against them.

Table, right, breaks down initial failures of 132 centrifugal pumps by general service area and part that initially failed. Further analysis shows *why* the majority of these failures happened.

Pump-shaft failures predominate—they represent 50%—so let's look at them first. Many feed-system centrifugal pumps (including boiler-feed) operate at relatively high speeds. So the wear and tear of misalignment is magnified. Failure percentages reflect this.

On the other hand, the possibility of foreign objects entering pump suction is far greater with other energy-system pumps (which include service-water pumps). But since a service-water pump usually runs at lower speed for higher capacities, it has generally larger internal passages. Many solids will pass through without causing enough internal stress to actually break the shaft, so here, the percent of failures tracing to foreign objects is relatively small.

Progressive cracking because of corrosion or vibration is a disease common to all pumps; this area needs maintenance emphasis regardless of pump type. At the design stage, proper material selection can minimize corrosion failures. First step here is to know all properties of the liquid pumped; then you're on reasonably safe ground as you go ahead with material selection.

Based on information supplied by The Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

Vibration can come from hydraulic cavitation or mechanical sources. Former should be a function of correct original application—but if you have a pump in operation which is cavitating badly, take immediate steps to relieve it. The process may not be cheap, but in the long run it will be far less expensive than letting the pump run to destruction. There are two ways to attack cavitation: First decide whether your system can be altered to increase suction head, by reducing pipe friction, increasing static head or perhaps cutting pumping temperature. Second, if these steps are not practical, perhaps the pump manufacturer can give you a different impeller design with lower npsh requirements.

Progressive shaft cracking due to mechanical vibration is inexcusable. All rotating equipment should be inspected frequently to be sure that vibration is well within allowable maximum set by the manufacturer. If it exceeds these limits, the pump should be taken off the line immediately and the cause of vibration determined and corrected.

Bearing failures are next on the list. The vast majority stem from lubricant difficulties, regardless of pump service. Loss of lube occurs when oil level falls too low or, in pressure systems, when the oil pump fails. Former is an inspection fault; latter can be overcome by providing a backup pump to cut in on low oil pressure.

Contamination of lubricant takes many forms. It may just be dirt. Even if an oil system is not exposed to the air, vents are provided to equalize air pressure with changing lubricant temperatures—letting the system breathe. These vents alternately draw in and expel air which may be loaded with dust or other plant impurities. Then, over a period of time, the impurities collect and form sludge. Answer here: inspect the lubricant as frequently as necessary to assure yourself that it remains satisfactorily clean. In critical equipment where bearings are pressure lubricated, a filter with bypass arrangement may be a good investment to continuously clean system oil.

Water is a contaminant too. It can enter a lubrication system through cracks in cooling jackets and oil coolers. But another water source is less obvious than these—condensation. As we have said, any lubrication system breathes—and to some degree it inhales water vapor. Temperature within the bearing housing dictates how much of the intake water vapor condenses out. When bearings are overcooled—to a temperature below the ambient wet-bulb—water vapor will condense out within the bearing housing. Since this water vapor has no other place to go, it will collect in the lubrication system and build up. Water contamination then promotes corrosion and ultimate bearing failure. (See POWER's series on circulating-oil lube systems, starting in April '61.)

Loss of main-pump suction is another source of bearing troubles, especially in relatively high-speed feed-system pumps. Vibration, caused by loss of suction, overloads the bearings, and they fail prematurely. Defective bearings show up more in feed-system pumps, also because of higher operating speeds which accelerate failure and will not long tolerate a marginal bearing.

Internal pump damage again breaks sharply between feed-system pumps and others. Condensate in feed systems is normally clean from a physical viewpoint—at least there are no sticks and stones in it. But these pumps are more prone to suction-side disturbances. Their high speeds accelerate the effects of suction troubles so that internal damage to impellers, wearing rings and interstage bushings can be extensive.

On the other hand, other energy-system pumps are frequently not blessed with such physically pure water. They're the ones that do catch the sticks and stones, so their greatest internal damage stems from foreign objects. The cure for feed-system pumps lies in proper operation and design—plenty of suction pressure margin. In other energy-systems pumps, suction screens will keep out trash that might cause internal damage. Be careful of suction strainers, though. Unattended, they can be worse than none at all. If suction strainers are permitted to load up, pressure drop across them increases with attendant loss of suction pressure. And so, out of the frying pan into the fire—you have kept out the trash only to ruin your pump because of loss of suction pressure.

Of course, the list of things that can go wrong with a centrifugal pump is endless, but these failures top the list. Odds are that special attention to these potential trouble areas will pay off in reduced maintenance and pump-replacement costs. And downtime will be cut too—a real money saver.

Pump-failure study shows you what to watch out for

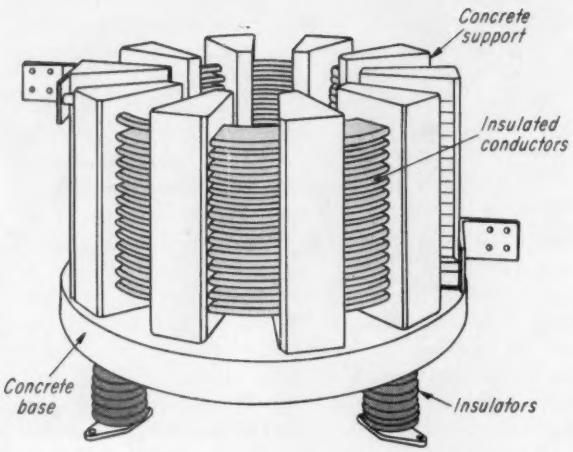
	Feed-system pumps	Other energy-system pumps	Total
Pump-shaft failures	14	52	66
Reasons for shaft failures			
Misalignment or poor shaft installation	50%	26%	
Progressive cracking (vibration, corrosion)	42%	54%	
Foreign objects	—	12%	
Other causes	8%	8%	
Bearing failures	23	32	55
Reasons for bearing failures			
Loss or contamination of lubricant	45%	71%	
Loss of main-pump suction	14%	3%	
Misalignment	9%	10%	
Defective bearings	14%	6%	
Other causes	18%	10%	
Damaged pump internals	4	7	11
Causes of internal pump damage			
Loss of pump suction	72%	8%	
Foreign objects	14%	80%	
Other causes	14%	12%	
Total failures	41	91	132

Plant Electrical Fact File

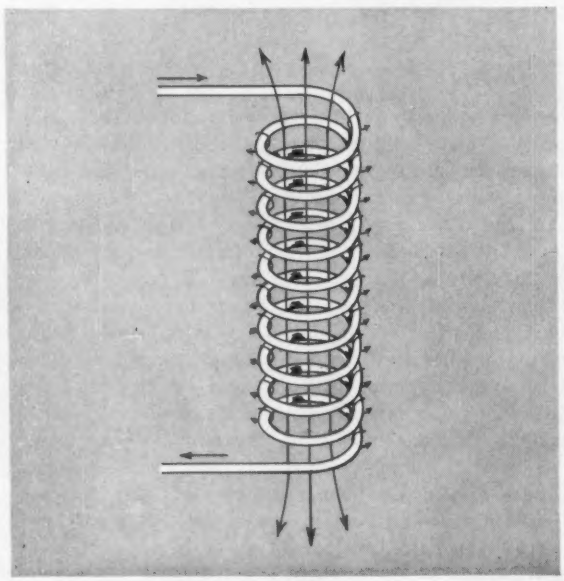
NO. 60: REACTORS

How to use reactors

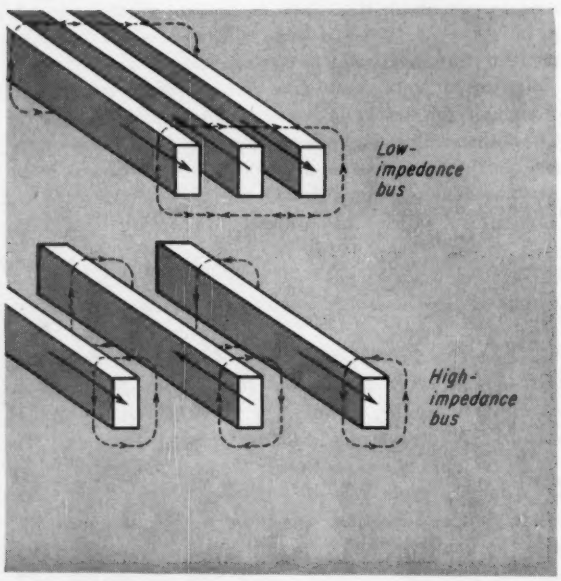
By NORMAN PEACH, Associate Editor



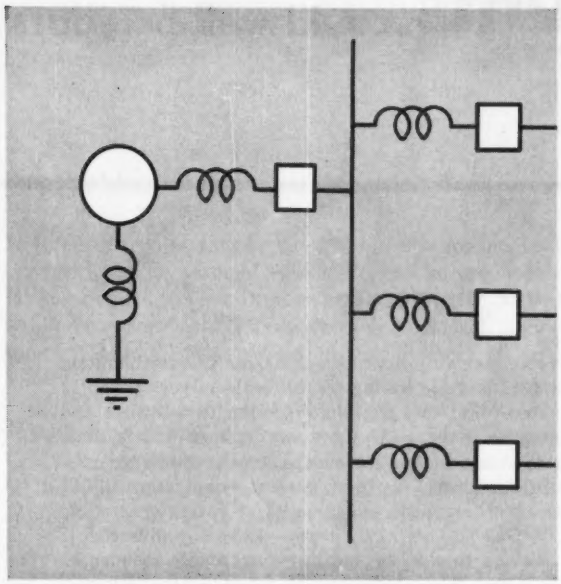
Air-core reactors handle current-limiting duty on low- and medium-voltage systems, usually indoors. Insulated turns of wire or strap are imbedded in concrete. This helps them withstand the tremendous magnetic forces of short-circuit currents produced in system when faults occur



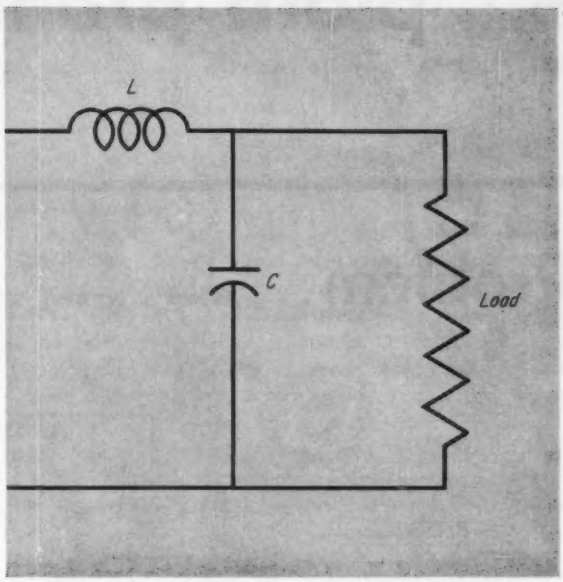
REACTANCE X_L results from self-induction of reactor coils. Changing current produces changing flux which cuts conductors and induces counter emf. $X_L = 2\pi fL$; for 60 cps, $X_L = 120\pi L$. L = inductance in henries. Reactors may have iron cores or air cores; saturable reactors were described in *Electrical Fact File No. 34*, March 1959



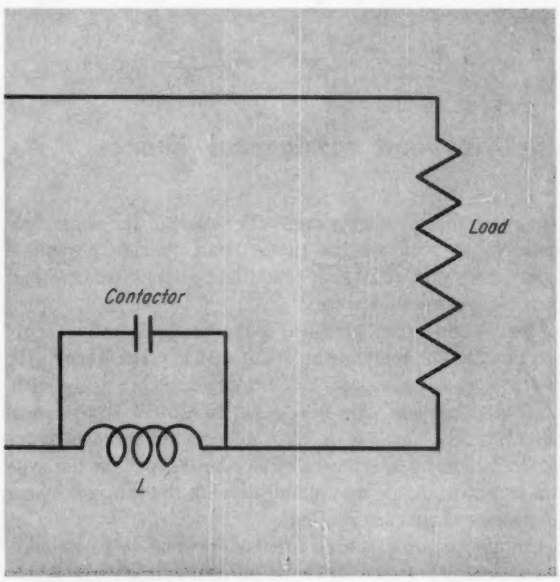
BUILT-IN REACTANCE is feature of current-limiting busway. Low-impedance bus bars are arranged so their magnetic fluxes cancel each other, though it's impossible to eliminate X_L completely. To limit currents during short-circuits, high-impedance bus is used. In this case, bars are arranged to permit desired reactance values



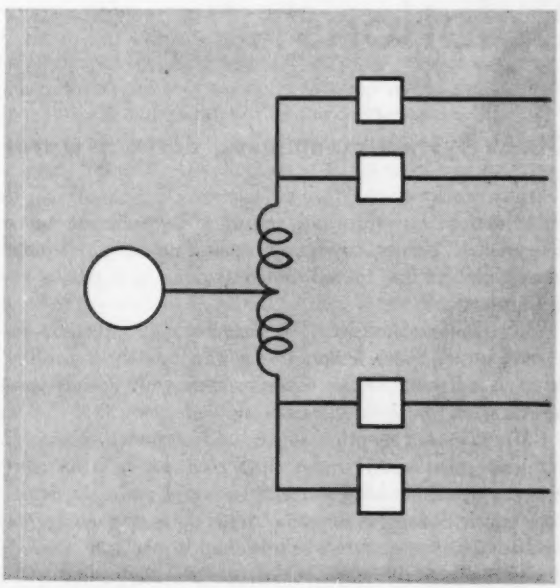
CURRENT-LIMITING is an important use of reactors in power systems: in generator leads, for connecting feeders to high-capacity bus, for limiting line-to-ground faults. One adaptation of latter is the Petersen coil, with inductance selected so it neutralizes capacitive current of the system to ground. See *Fact File No. 20,* December 1957



FILTERS are used in rectifier and inverter circuits and various electronic devices. Reactors usually have iron cores. $X_L = 2\pi fL$, so for the proper value of L, magnitude of X_L will depend on frequency f. Current of desired frequency passes low reactance while high reactance blocks current of undesirable frequency from the system



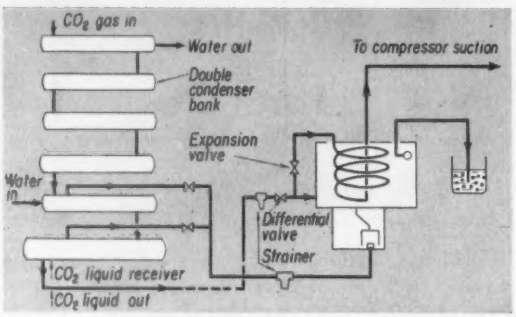
VOLTAGE-DROPPING by reactance is sometimes desired, as in motor starting circuit shown. Contactor cuts out reactor when proper speed is reached (*Fact File No. 6,* Sept 1956.) There is always some voltage drop across a reactor, even one used only for current-limiting in case of faults. Naturally, there is always some power loss as well



LOAD DIVISION may be improved by reactors. Duplex-reactor scheme in conjunction with generator is designed to reduce transfer of short-circuit currents, above. Other arrangements adjust division of current between parallel circuits or transformers. Reactors are used to avoid open circuits when operating transformer load-tap changers

These **plant problems** could well be yours...

Problem... What's wrong with our air purger?



We have an air purger for our 200-ton CO_2 refrigeration system, and are having trouble with purger operation.

According to CO_2 liquid-receiver temperature and pressure, we have 75-psig excess pressure in the system. Compressor suction pressure is 80 psig, discharge pressure 1050 psig, condensing-water temperature 72 F. An orsat test made at the outlet of purger vent read: CO_2—95.6%, O_2—0.2%, inerts—4.2% (by difference).

To try to find or localize our trouble, condenser tubes were thoroughly cleaned, thermometers and pressure gages checked for accuracy. All was OK.

We will welcome suggestions from any reader who can help us solve this problem.—*GMD, April* POWER

Solutions...

Check system cleanliness, correct water quantities and refrigerant charge

High system pressure may result from one or more deficiencies. Faulty condenser performance, a frequent cause, may be due to reduced heat-removal capacity resulting from:

(1) Insufficient water. Measurement of condenser inlet and outlet water temperatures will indicate if cooling range is adequate. Then a comparison with design temperatures shows if there's too little water.

GMD does not mention source of his condenser's cooling water. Decreased water flow rate through the condenser may result from partial closing of manually operated valves, plugged screens, leaky pump packing or decreased main pressure of the water. It might be a good idea to measure actual water flowrate and compare it with specified values.

(2) Fouled tubes are usually indicated when temperature of water leaving the condenser is very low—the water-temperature range is much less than the design value.

GMD states his condenser was cleaned. But cleaning may have removed dirt and other foreign matter only. It is possible that excessive mineral content of the water has deposited as scale on the tubes. Also, marine growth—algae—may prevail. Algae sometimes appear when water temperatures are moderate.

Ideally, condenser pressure corresponds to refrigerant-gas condensing temperature. But usually the former is greater due to the presence of noncondensable gases such as air and oxygen. Air may leak in around compressor shafts or rods. Tight seals are a must to cut leakage. During initial charging, some air may be trapped in the system. In addition, air may combine with the lube oil when compressor crankcase is filled.

Another possible source of noncondensable gases may be a reaction between the lube oil and refrigerant, when they're under high pressures and temperatures.

A check of refrigerant quantity is useful. High head pressure will result if too much refrigerant is used—liquid refrigerant flows over from the receiver into the condenser, decreasing effective heat-transfer area, leading to high condenser pressures.—H B WAYNE, *Woodhaven, N.Y.*

...Here's how Power readers would tackle them

LAWSON STEWART, Associate Editor

Try colder water and purging

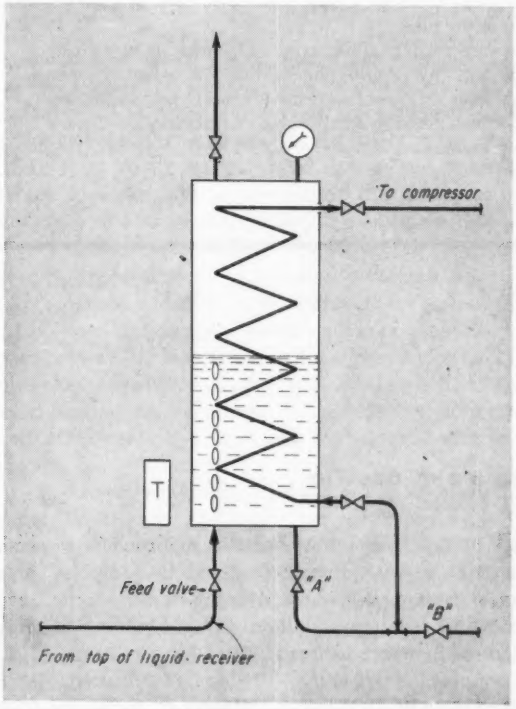
In studying the diagram for the 200-ton CO_2 refrigeration system, I had to assume certain physical arrangements. My suggestions, in view of these, are:

(1) Introduce cold water into each condenser from a common header, thus permitting colder water in each heat exchanger.

(2) Be sure the line from the liquid receiver to compressor suction is sized properly for the flow.

(3) It seems that purging from each condenser could be desirable (the direction of flow arrows on some lines appears to be wrong to return condensed gas).

M L MYERS, *Knoxville, Tenn.*



Install equipment right!

You can't expect improperly installed equipment to function correctly. In *GMD's* case, the omission of a valve between the differential valve and the shell of the purger is going to let one of several things happen, depending upon the setting of the differential valve—and none of these things are conducive to correct operation. Sketch shows the correct method of installing a refrigeration purging device.

In operation, shell should be kept from one-half to three-quarters full of liquid refrigerant cooled as far as possible. Don't feed gas-vapor mixture any faster than the vapor (CO_2) content of the mixture can condense in the liquid refrigerant. Keep pressure in the shell as high as possible, bleeding to atmosphere so that shell pressure will be about 20 lb below condensing pressure. When liquid level reaches the ¾-full mark, close valve *B* and drain through *A* and expansion valve.

With arrangement shown and following my instructions, test should show 10% CO_2, 90% noncondensables at purger outlet.—J BRODSKY, *Newark, N.J.*

System needs a better layout

From *GMD's* sketch, I gather that this purging system was designed with complete disregard for basic physics or good refrigeration design.

In the first place, purging lines should always be located at the highest point of the receiver—as they are. But they should also be hooked up at the highest point of the condenser, whether it be double-pipe, shell-and-tube or evaporative type, not at the lowest point as they are now. The greatest point of air concentration in the system will always be found at the top of the condenser.

In the second place, the overflow line from the purger and the liquid line to the purger evaporator are incorporated into one. Movement of refrigerant to the purger evaporator restricts overflow from the purger itself. In order to overcome this, the purger's overflow line should be connected at a point on the shell approximately one-third of the way up from the bottom of the evaporator coil and extending to the lowest point of the receiver.

Third, a control valve should be installed on the purge line, as close as possible to the purger.

Fourth, a control valve should be installed on the vent line from the purger.

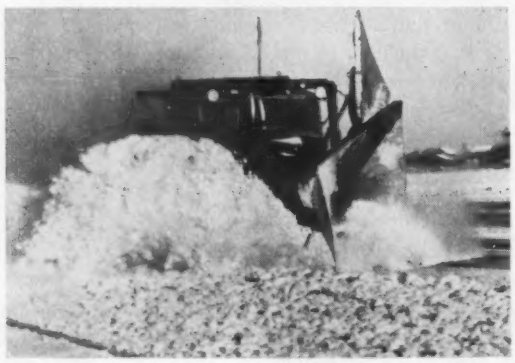
From this point on, operator's ability means the difference between success or failure. He must balance the purge-line control valve, the expansion valve and the vent valve so that liquid level in the purger stays just a little higher than the overflow line. The receiver and the condenser should never be purged at the same time.

J L DOWNING, *Brooklyn, N.Y.*

Want some help on plant problems? Send us any of your design or operating headaches for *Power* reader comment

More **plant problems**

Problem . . . How can we speed snow melting?



We have a 100x100-ft blacktop parking lot adjacent to our boiler house. Our problem is snow removal during the winter—and we're situated near the Great Lakes so winter usually means lots of snow. One solution to snow removal would be to bulldoze snow into a pit approximately 4-ft wide running the entire length of the boiler-house wall. We would like to mount steam coils in the pit and melt snow as it is pushed in. Accumulated water would be handled by an existing drain in the pit.

Do any readers have experience with snow-melting problems? We would like to find out whether open steam lines or closed systems are best. Also, what are heat-transfer and weight-volume characteristics of snow under various conditions?—*GAP, April* POWER

Solutions . . .

Closed-loop steam or radiant heating may be your answer

If *GAP* wishes to use steam for snow melting he should run it through a closed loop. It would be very wasteful and expensive to use an open steam line since all the condensate would go down the drain. The lost condensate would have to be replaced by makeup water, requiring, in most boiler plants, treatment to remove the impurities.

It would be better to install a shell-and-tube heat exchanger, with at least 3,000,000-Btu-per-hr output, in the boiler room. The snow-melting coils then should run from the heat exchanger to the pit in a closed circuit. A circulating pump should be installed in the circuit to the coils.

The solution in the coils should be either a heating oil or a mixture of ethylene-glycol antifreeze with water. Add a rust inhibitor and proportion the solution to prevent freezing at –30 F. Correct proportions of the solution may be determined by using an ordinary hydrometer to check the specific gravity. Provide for adding additional antifreeze to the system without shutting down.

Snow that has been bulldozed into the pit will be semi-packed—somewhere between 20 to 30 lb per cu ft.

If the pit is 100-ft long, 4-ft wide and 6-ft deep, then it has a volume of 100x4x6 = 2400 cu ft. Assuming snow density of 30 lb per cu ft, 2400 x 30 = 72,000 lb of snow if the pit is filled. If the snow temperature is 22 F, it must be warmed 10 F to melt. 72,000 x 10 equals 720,000 Btu.

Latent heat = 142 Btu per lb. 72,000 x 142 = 10,224,000 Btu required to melt all the snow in the pit.

To melt the snow in five hr requires 2,500,000-Btu-per-hr output of the coil.

Another method that could be used would be to install gas-fired radiant heaters over the pit. These heaters produce rays that heat like the rays of the sun. Their capacity

is about 24,000 Btu per unit; they may be assembled in groups of two, three, four or six units, making it possible to get a heater of 6 x 24 or 144,000-Btu-per-hr output. To melt the snow in five hr would require 17 unit heaters mounted over the pit.

Of course this type of heater could be mounted over the parking lot itself. This would melt the snow from the lot without the trouble and expense of bulldozing into the pit. I suggest that *GAP* investigate this possibility—it would perhaps be the most economical.

S R Higgins, *Long Beach, Calif.*

Use flooded pit

A concrete pit flooded with hot water may be *GAP*'s best bet. With this design, snow is bulldozed into the flooded pit. Coils are submerged, so the heat-transfer surface can be fully utilized. As the snow melts, the resulting mixture of warm water and melted snow discharges to waste, but a weir inside the pit keeps coils submerged at all times. Maintaining a sufficient height of water above the coils provides an insulating blanket, reducing the possibility of ice forming on the outside surface of the coils when they're out of operation for a short time.

GAP does not mention available steam pressure, temperature and feedwater properties. Feedwater may require chemical treatment and preheating, which makes a closed system the economic design. With this arrangement, condensate returns to the feedwater circuit to cut makeup.

To prevent possible freezing during shutdown, complete drainage of the coil and piping is necessary. Even with a pitched system this problem is difficult to avoid. So I prefer a forced-circulation hot-water system containing an antifreeze solution. Besides, more-uniform heat transfer is available with forced circulation.

GAP states his parking lot measures 100 x 100 ft, giving an area of approximately 10,000 sq ft. For this service, I recommend a snow-melting system employing radiant heating. The design precludes bulldozing, so labor savings and elimination of bulldozer fuel cost help justify this type of installation.

Snow density is influenced by ambient temperature. A thermal-conductivity figure of 0.3 Btu per sq ft, hr, F per ft may be used for design purposes. Since the proposed installation is located in the Great Lakes area, local meteorological data should be consulted—the municipal weather bureau or nearest airport are reliable sources.

H B Wayne, *Woodhaven, N.Y.*

Your July problems

What kind of bearings for our motors?

We had quite a problem recently with three small motors to run under high temperature, with no lube and no maintenance. We tried carbon bearings but were unable to make them perform satisfactorily. We finished up with special ball bearings designed for the temperature, but we still have high-temperature problems which means the ball bearings probably are not our ultimate answer.

Our motors are 1/100-hp 3200-rpm single-phase shaded-pole ¼-in.-shaft units, so bearing speed is only about 200 ft per min. These motors have to run at 180 F, 100% humidity ambient.

We know nylon and teflon cannot take the temperature. Carbon was fine with just a drop of oil on it, or if there was enough water on the surface. But running dry, the carbon bearings would either screech or try to seize up or not start at all.

What has been the general success, or lack of it, with carbon bearings? Has anyone with similar operating conditions found a way to make these bearings last? Has anyone found a different type of bearing material that can stand up to these operating conditions? We would like to hear from Power readers who have figured out this problem.—*GR*

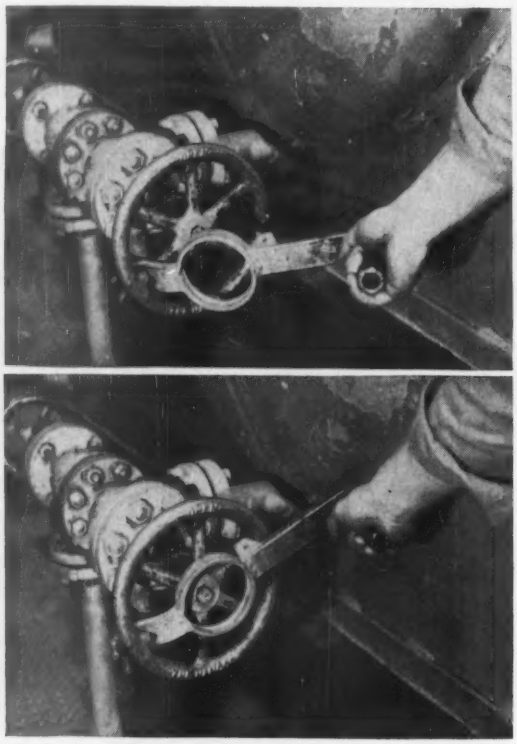
How do we acid-clean our boiler?

We have had no experience descaling a boiler with acid treatment. However, we are planning on doing just that to our 380-hp 3-drum watertube boiler. We intend to use sulfamic acid at the rate of approximately ¼ lb per gal and to boil the acid-water mixture in the boiler for 24 hr.

Analysis of the scale indicates it's primarily calcium and magnesium carbonate and, as such, readily dissolves in acid. We would like information on techniques and procedures of acid-cleaning a boiler with sulfamic acid. Any help Power readers can give us would be greatly appreciated.—*DLH*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve



Portable valve handle saves a lot of time

Our three boilers have identical handwheels. To make valve operation easier and faster, one of our engineers came up with the idea of making a crank handle, photos. The lugs fit the valve spokes snugly so the handle won't slip during operation. Handle is easy to remove and can be used on any valve.

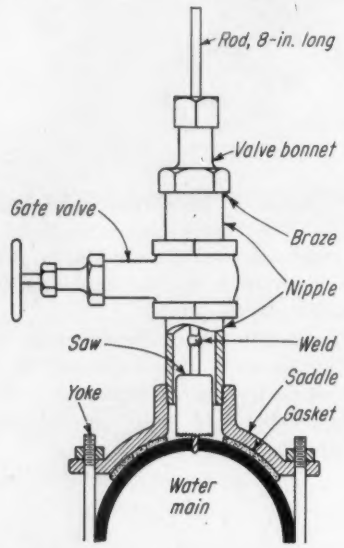
C TRETINYAK, *Rochester, Minn.*

This is how we align our V-belt sheaves

Life span of V-belts may drop greatly if the sheaves are not properly aligned. Usual method of checking alignment is to place a straight edge against the end faces of the sheaves. But if the faces have a slight wobble, results can be misleading.

We have found a more reliable method of checking alignment, sketch. We first align the sheaves by sight, then tighten them lightly. A straight piece of shafting is placed across the sheaves, in the grooves. Its diameter should let it touch the sides of the grooves at about the pitch line. If we lift one end of the shaft and then let it settle slowly back into the groove, it will move to one side if the grooves are not aligned. When this occurs, we know we must move the sheave in the opposite direction.

L KASPER, *Philadelphia, Pa.*



Tapping into a water main

Having to make a 2-in. tap into a 6-in. water main, we were faced with an expensive shutdown. So we put several heads together and the brain trust came up with the tool shown.

We bought a 2 5/16-in. hole saw and mandrel. The saw is about 3-in. deep so it will take care of the curvature of the pipe. We then removed the stem and packing from a 1-piece bonnet of an old valve and brazed the bonnet to a 2½ x 6-in. nipple. Since we had removed a ⅝-in. stem, we welded an 18-in. length of ⅝-in. cold roll to the mandrel of the hole saw. Then we inserted the cold roll in the bonnet in place of the original stem. We repacked the bonnet with lubricated packing, then pulled it up finger-tight and pushed the saw into the nipple.

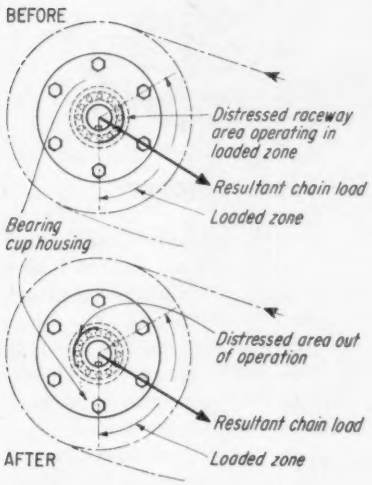
In the meantime we installed a saddle, nipple and 2½-in. full-ported gate valve on the 6-in. main. The valve was opened wide.

We screwed our tool into the valve and pushed the stem in until it touched the pipe. Using a slow-speed electric drill and minimum pressure until the pilot drill had centered itself, we cut our hole in the 6-in. pipe. Then we withdrew the saw until it was clear of the gate valve, closed the valve, removed our tool. Presto—the tap was made. All that was left to do was connect the piping.

M SHERRITT, *Columbus, Ohio*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor



Bearing life is extended

A few days before a scheduled plant shutdown for inspection and repair, a gear reducer on our coal-handling equipment began to give us trouble. The tapered roller bearing located next to the chain sprocket on the output shaft suddenly got noisy.

Inspection showed that part of the bearing's outer-cup raceway was in distress. During long operation, the heavy chain load continually stressed the same part of the raceway. This in turn caused gradual surface failure in the raceway's loaded zone.

As a quick emergency measure, we rotated the bearing-cup housing 180 deg from its former position. Remounting it in this new location moved the distressed area away, sketch. This presented a new working surface for the loaded zone.

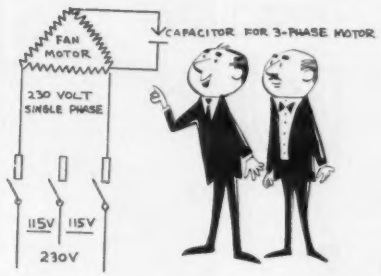
This trick restored the bearing and reducer for a few more useful days. We prevented a serious breakdown and interruption in plant operation, and were able to make the permanent repair at regular shutdown time.

E WITTMAN, *Villas, N.J.*

Send it to Power

Your practical idea is worth money. Send it with a photo or sketch and it'll net you several dollars more.

STEVE ELONKA



What would you have done?

An SOS came to my home one evening about an electrical problem in a new restaurant. The electrician had spent two days trying to start the kitchen exhaust fan. He couldn't do it. The owner filled in the details of the problem while driving me to the restaurant.

The roof-fan housing had a new, special-frame dual-speed 9-lead fan motor with a hub for the fan blades. It was lying on the floor. "How come?" I asked. The owner replied, "The motor that came with the unit wouldn't run." The maintenance man chimed in, "The electrician said the motor is NG. So we followed his advice and got a new one, but this damn motor won't run either."

"Check the fuses?" I asked the maintenance man. With his test lamp—two small bulbs in series—he demonstrated that they were OK. "How about the magnetic contactors?" "Brand new and also OK." "Well then, put the switch on and start the motor," I ordered. When he did, the motor groaned and growled. I checked the 9-lead motor connections but found nothing wrong.

By then everybody was pretty impatient. I took a voltmeter out of my bag and checked, not the fuses but the voltage. It was unbelievable—I got 230-115 v single phase. I thought the electrician had made a mistake, connecting the wires leading to the fan housing on the wrong terminals in the main panel. But I was surprised to find the electrical service entering the premises was only 3-wire, single phase, 230-115 v. There was no 3-ph service available.

What could I do to get that 3-ph fan motor running on single phase? I started the gears grinding. I called a friend, asking him to bring a carton of capacitors which we used for pf correction.

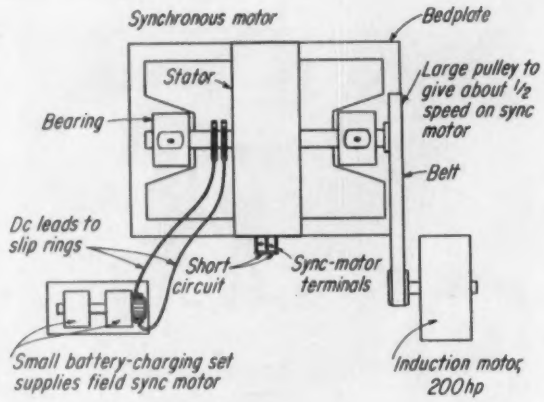
I grouped the capacitors in series-parallel and zip, the fan motor started. A week later my boss handed me an envelope. "Carl," he said, "that was a nice job and good thinking. You earned every dollar contained in this envelope."

What would *you* have done?—C BACHMAN, *Jamaica, N.Y.*

These ten traits hold the key to success

Do you have these ten characteristics? Our most successful men all have them in some measure. And this holds true whether or not they have a college education. Here they are: (1) Drive (2) broad interests (3) ability to organize (4) ability to rise to challenges (5) self-reliance and basic security (6) ability to be realistic (7) intelligent use of time (8) stamina (9) originality—ideas (10) knowledge. Please note: DRIVE comes first.

More **practical ideas**



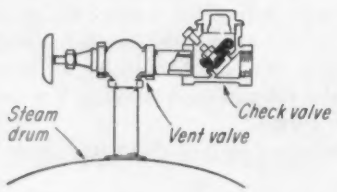
Motor winding gets a drying out

A shipment of electrical equipment for a paper mill was involved in a railway accident. One of the items dumped into a snowbank: a 2600-hp 2200-v synchronous grinder motor. It lay for a couple of days with a smashed protective housing before it could be reloaded. In the meantime the weather turned mild and its exposed windings got their share of a thorough soaking.

When the motor finally arrived at the mill, megohmmeter tests showed its winding insulation had too low a value for safe operation. Problem: dry the winding out as soon as possible—before moisture could do further damage. During construction the mill was poorly heated by steam; there were no electric heaters available for drying. The main electrical power supply had not been connected, though some power was provided by small diesel-generator units.

I had a 200-hp motor removed from a barking drum, installed a belt drive to run the synchronous motor at half speed. A small motor-generator set was placed nearby to supply dc to the field of the synchronous machine. Then, with the terminals shorted, we had found an ideal method of drying out a motor winding.

L McWilliams, *Shawinigan S, P.Q.*



Boiler vent now operates automatically

Our practice when taking a boiler off the line was to watch it closely until pressure dropped to five psi. Then we opened the vent.

I installed a short nipple and swing-check valve on the vent, sketch. Now we open this valve when shutting down a boiler. The swing check holds the pressure. But soon as pressure is off the boiler, vent automatically opens, venting the boiler. A piece of welding rod keeps the check open during warming-up period.—V J Donohue, *San Jose, Calif.*

My biggest boner

The new 12-ft-dia 150-ft-high steel stack was going up. Each 6-ft-high ring of three curved plates was raised, positioned and aligned. The rings were temporarily fastened to hold alignment while three vertical butt joints and the circumferential horizontal butt joints were welded.

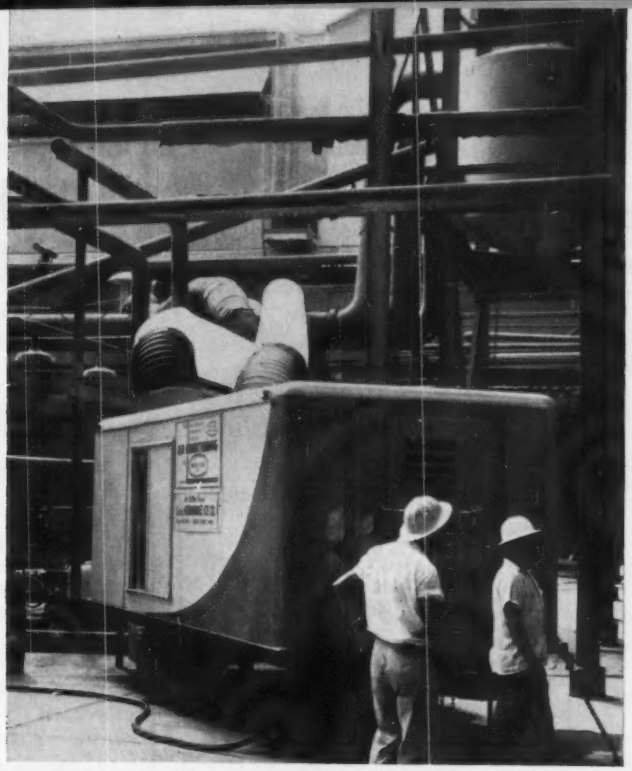
As the structural inspector, I checked the stack daily. My plumb bob hung down to the stack's base from the center of a temporary frame across the top ring. I would also sight a transit on the side of the stack's base. Then, swinging the telescope slowly upward, I would sight up along the side to be sure the stack was vertical all the way up.

I made these checks each morning before the sun came up. But then, sun striking one side in the morning would heat that side, making it expand and lean away. In the afternoon, when the sun heated the opposite side, the stack would list in the opposite direction. I figured the finished stack's movement could possibly be 5-in. out at the top.

When the stack was three-fourths completed, I checked it with the transit one afternoon. It was out of plumb about two in. The prime contractor and I conferred with the stack subcontractor. We came to a meeting of the minds and cooperated—in pulling a boner. We cut the stack four rings from the top and straightened it.

One morning after sunup I checked again. The stack was, of course, leaning in the opposite direction. It was too tall and too heavy to be cut again at the same joint, so we cut and straightened it at a higher joint. Now, our finished stack bends in two places. I'm happy to say it's not noticeable to the casual observer, but to the three boneheads responsible, it looks like a dog's leg.

A D Jones, *Tampa, Fla.*



PUMPING CONDITIONED AIR into hot furnace cools it down fast. Net saving: as much as two-thirds of downtime usually needed. Unit is working in record time

Today, you can cut outage with . . .

Portable conditioners

They heat, cool or ventilate any location to help you work quickly, comfortably for efficient turnaround

How often does a plant engineer have to sit and twiddle his thumbs while he waits for a furnace to cool down enough for inspection and repair? How often must he postpone badly needed work because high humidity would knock out his maintenance crews before they got properly started? Excessive heat, too much cold, humidity or lack of adequate ventilation have long been a nuisance to industry. These gremlins hamper construction work, stretch downtime for repair and maintenance. Result: the unavoidable loss of large chunks of time and large sums of money.

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One of these triple-threat units can be connected to the access doors of that red-hot furnace or any heated vessel. 18,000 cfm of air are pumped inside until a temperature as high as 2000 F drops to, say, 600 F. The air conditioning is then turned on to drop the temperature further, from 600 F to a workable level. This method can cut cooling time by two-thirds. You can proceed with your normal repairs without delay, get the unit back into operation fast.

Machines are rented or leased, by day or year. Standard units provide 600,000-Btu air-conditioning capacity to defeat heat and humidity, 1,200,000 Btu of heating to combat excessive low temperatures, 18,000-cfm capacity for proper ventilation. One unit can move around to service any desired location; plastic ducts hook it up to its power supply.

Main use for the portable conditioners is in vessels such as furnaces, boilers, heaters, regenerators, tanks, cat crackers. At present they are used by shipyards and oil refineries as well as power plants proper, in the construction field and in new buildings for space heating or cooling during construction.

The chilled-water air conditioner refrigerates with ice. It uses both a spray chamber (to filter and cool air) and a series of water coils (to dehumidify and cool air). Placing a condensate or a regular steam line in the ice-melting chamber turns the unit into a high-capacity heater for extremely cold areas during the winter. Large blowers deliver 18,000 cfm at 1½-in. static pressure. Energy source: an i-c engine with muffler. Explosionproof electric motor rated 220 to 440 v, 3 phase, 60 cycle, plus starters and external power receptacle, completes the portable setup.

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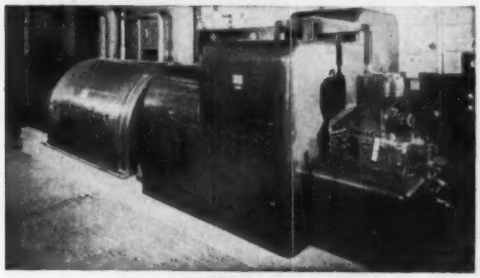

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700	G.E.	Slipring	2300	400
700	G.E.	Slipring	2300	514
600	G.E.	Synch.	480	900
600	Elliott (2)	Sq. Cage	2300	900
500	G.E.	Slipring	2300/4000	514
500	Al. Ch. 3 brg.	Slipring	440	514
500	G.E. b.b. (2)	Synch.	2300/440	1200
450	Allis Ch.	Sq. Cage	2300/440	720
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2200/440	600
400	G.E.	Synch.	550/2200	400
400	Whse.	Sq. Cage	440	1200
350	G.E.	Slipring	440	900
350	El. Machy.	Synch.	2300	900
300	G.E.	Slipring	220/440	514
250	G.E.	Sq. Cage	440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	Gen. Elec.	Synch.	550/440	400
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
200	G.E.	Sq. Cage	2300	450
150	Reliance b.b.	Sq. Cage	220/440	900
150	Whse. b.b.	Sq. Cage	440	1800
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150	G.E. (4)	Slipring	2200/440	600
150	Whse.	Slipring	220/440	1200
150	G.E.	Sq. Cage	2200/440	600
125	Whse. b.b.	Sq. Cage	220/440	900
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	G.E.	Sq. Cage	2300/440	1200
100	Star b.b.	Sq Cage	220/440	600
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
100	G.E. b.b.	Sq. Cage	220/440	3600
100	G.E. TEFC	Sq. Cage	220/440	1200
75	A.C. TEFC	Sq. Cage	2300/440	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
350	G.E.	MPC	250	900/1200
250	Cr. Wh.	101-H	230	1150
200	Whse. b.b.	8K	250	287/375
150	Reliance b.b.	1050-T	230	1150
150	Rel. TEFC b.b.	2550-F	230	850
125	G.E.	CD-175	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2)	30-S	230	450/1200
75/100	Whse.	SK-191	230	300/900
75	Reliance b.b.	383T	230	850/1700
60	G.E. TEFC b.b.	CD-135	230	1150
30/40	L.A. b.b. (2)	ONW	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
300	G.E.	440 AC	250/350 DC
200	Allis Ch. (2)	440 AC	250 DC
200	Whse. synch.	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
100	Delco b.b.	220/440 AC	120/240 DC
80	Star b.b. Synch	220/440 AC	250 DC
75	Allis Ch. b.b.	220/440 AC	125 DC
50	G.E.	220/440 AC	250 DC

Arthur Wagner Co.

Certified

MO nroe 6-7409

1435 W. RANDOLPH ST

CHICAGO 7, ILLINOIS

Circle 516 on Reader Service Card

TRANSFORMERS

BOUGHT · SOLD · RENTED

REWOUND · RE-DESIGNED

MANUFACTURED

Ask for our Stock List

For Sale

3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800/11000
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y
3—1000 KVA G-E 34500—7200/12470Y
3— 833 KVA W-H 43800—480

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio

"America's Exclusive Independent Transformer Service Shop"

Circle 517 on Reader Service Card

POWER EQUIPMENT

1500 KW, Elliott, Cond. Turbo-Gen. 3/60, 2300 V., 5000/1200 RPM, 250-400 PSIG, 525°-750°TT.

1000 KW, West. Cond. Extr. Turbo-Gen. 3/60, 245/490 V., 3600 RPM, 130-230 PSIG, 386°-500°TT, 10# Extr.

1000 KW, G.E. Non-C. Turbo-Gen. 3/60, 2300 V, 3600 RPM, 400 PSIG, 600°TT, 90-125 PSIG Exh.

1000 KW, Worthington, Non-C. Turbo-Gen. 3/60, 240/480 V, 4500/1200 RPM, 155 PSIG, 470°TT, 5-10 PSIG Exh.

1000 KW, G.M. 16-278A, Diesel Units (2) 3 ph. 60 cycle, 2300 V, 720 RPM.

300 KW, GM. 8-268A, Diesel Units (2) 3 ph. 60 cycle, 480 V., 1200 RPM.

BREW, WOLTMAN

& COMPANY, INC.

50 CHURCH ST., N.Y. 7, N.Y.

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MOTORS · GENERATORS
TRANSFORMERS
NEW · REBUILT

ELECTRIC EQUIPMENT CO.

WORLD'S LARGEST INVENTORY
CALL COLLECT CL 4-9058
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B O I L E R S

TURBO-GENERATORS · DIESELS

PUMPS · FANS · BURNERS · HEATERS

Large Selection . . . New and Used

EXPERIENCED ENGINEERS TO ASSIST YOU

WABASH POWER · EXPORT ·

WABASH

POWER EQUIPMENT CO.

Phone: IN. 3-0303

3300 W. Peterson Ave. Chicago 45, Ill.

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BABCOCK & WILCOX COAL PULVERIZERS

2—NEW UNUSED Babcock & Wilcox coal pulverizers, Type E-56, each equipped with American Blower Corporation air fan, 15,000 cfm capacity with motor drive. These are complete coal pulverizer installations with blower air fans, attached and unattached structural parts, capacity 20,000# coal per hour each pulverizer. Exceptional bargain.

UTILITIES MACHINERY CORPORATION
1965 East Sixth Street, Cleveland 14, O.

Circle 521 on Reader Service Card

RE-NU-BILT ELECTRICAL EQUIPMENT

53 YEARS SERVICE

MOTOR GENERATOR SETS

Qu.	KW	MAKE	RPM	AC VOLTS	DC VOLTS
2	4800	G.E.	450	2300/4600	250/300
1	2500	WHSE.	720	2300/4160	600
1	2100/2400	G.E.	450	2300/4600	250/300
2	1750/2100	G.E.	514	2300/4600	250/300
1	2000	G.E.	514	2300/4600	600/660
1	1500	G.E.	720	13200/6600	600
1	1250	WHSE.	720	2300/4000	600
1	1000	G.E.	900	2300/4000	600
1	1000	G.E.	900	6600/4000	250
1	1000	G.E.	720	2300/4000	275
1	500	G.E. Unused	1200	2300	300
1	500	G.E.	900	2300/4600	250
1	500	G.E.	900	440	250/125
2	300	G.E.	1200	2300	275
1	300	WHSE.	1200	2300/4160	600
1	200	G.E.	1200	2300/4160	250

FREQUENCY CHANGER SETS

Qu.	KW	MAKE	FREQ.	VOLTAGES
1	12500	WHSE.	60 To 25	13200-13200
1	5000	G.E.	60/50/60	11000-6600
1	2500	G.E.	60/24/60	2400-2400

3 PHASE 60 CYCLE MOTORS SLIP RING

Qu.	HP	MAKE	TYPE	VOLTS	SPEED
1	1750	G.E.	M-579BS	4800/2400	1800
1	800	G.E.	MT-428	2200	450
1	800	WHSE.	CW	550/2200	1776
1	600	WHSE.	CW-32D	440	1775
1	600	WHSE.	CW	440	850
1	550	WHSE.	CW	440	252
1	500	WHSE.	CW	2300	881
1	500	WHSE.	CW	550/2300	330
1	300	AL. CH.	ANY	2200	720
1	300	GEN. EL.	MTP-561	2200	1760

SQUIRREL CAGE

Qu.	HP	MAKE	TYPE	VOLTS	SPEED
3	1500	G.E.	K.D.P.	2300	3580
1	1000	AL. CH.	ANW	2300	1180
1	550/275	WHSE.	CS-1115	2300	863/445
2	500	WHSE.	CSP-583H D.P.	440	3600
4	500	AL. CH.	ARW-D.P.	2300	3600
2	450	EL.	FR3910	2200	1185
1	400	WHSE.	CS7151	6600	3565

OUTDOOR G.E. METAL CLAD SWITCHGEAR 600 V. 3 POLE, A.C.B.

1—3000 AMP., AL-2-75, ELEC. OPER.
1—1000 AMP. AL-2-50, MANUAL
4— 800 AMP, AL-2-50 MANUAL
1— 400 AMP., AL-2-50 MANUAL
3—SPARE COMPARTMENTS

PUMPS — MOTOR DRIVEN

6—600 G.P.M. Gould, Figure 3360, 8 Stage, 2310 Ft. Head, 1000#, 3550 RPM, Each coupled to 500 HP 3-60-3550 RPM D.P. Sq. Cage Motor

2—WHSE, Type CSP-583H, 440 volt

4—Allis Type 2300 volt Magnetic Encl. Reduced Voltage Starters

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

Phone: OL 3-3334—N.Y.C. RE 2-7150

Circle 522 on Reader Service Card

SEARCHLIGHT SECTION

38 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2300/440	G.E.	600
400	4000/2300	Whse.	720
350	440/220	G.E.	1800
300	4000/2300	G.E.	720
300	440	Whse.	3600
250	4000/2300	Al. Ch.	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	440/220	G.E.	1800
150	2200/440	Whse.	720
125	2300	G.E.	900

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2200/440	G.E.	ATI	720
300	2300/440	G.E.	TS	1200
300	440	G.E.	TS	720
150	440/220	Whse.	G	1200

SQUIRREL CAGE MOTORS

500	2300/4000	G.E.	FT	1200
500	2200/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	BEDP	3600
350	2300/4000	G.E.	K	600
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	2300/4000	G.E.	K	720
250	2300/440	G.E.	K	1200
200(2)	440	G.E.	Dr-Pf.	720
200	2300	G.E.	KT	1800
200	2300	Cont.	TEFC	3600
150	440	El. Mchy.	Dr-Pf.	900
150	440	Whse.	K-pf.	3600
150	440/220	G.E.	TEFC	720
150	2300/440	G.E.	TEFC	3600
125	2300/440	G.E.	FT	1200
100	440	Whse.	TEFC	3600
100	440	Cont.	K-pf.	1800
100	2200	G.E.	FT	900

CIRCUIT BREAKERS, 3 Pole

2—1600 Amp., G.E., AL-50, 600 V., Air
1—1600 Amp., G.E., AL-50, 600 V., outdoor
1—1200 Amp., Whse., F-124, 7.5 KV, manual
1— 600 Amp., G.E., 15 KV, Sol. oper.
1— 600 Amp., Whse., 7.5 KV, outdoor, New.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
140	230	G.E.	CD	850
100	230	Rel.	1050T	300/1100
90	230	G.E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input., AC	Motor Type	Output V., DC
300	Whse.	4150/460	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2300/440	Syn.	230
65	G.E. B	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

3—500 kva, G.E., 13,800—240/480 V.
3—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Whse., 2400/4160Y—240/480 V.
1—300 kva, Whse., 4160—480 V., Dry, New
3—250 kva, Whse., 2400/4160Y—240/480 V.
3—240 kva, G.E., 460—230 V., 3 ph. Dry
3—200 kva, G.E., 2400—440V, Pyr.
3—200 kva, G.E., 13,800—480 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—230 V.
3—150 kva, G.E., 13,200—2300 V.
1—150 kva, Whse., 4160—120/208Y V., 3 ph. Dry
3—150 kva, G.E., 460—230 V., 3 ph. Dry
3—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

Circle 523 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

SQUIRREL CAGE MOTORS

HP	RPM	MAKE	VOLTS	TYPE
1500	1800	Al.-Ch.	2300	Ventilated
1250	3600	Al.-Ch.	4000	DP/PF
800	600	West.	2300	CS-44
600	600	West.	2300	CS-12
500	1800	G.E.	2300	KT-565Y
500	1200	G.E.	2300	FT-567
350	1200	West.	440	CS-3255-6H
300	720	West.	2300	CSF-34
300	600	West.	440	CS-39A
250	1300	Brook new	220/440	R-28
200	900	West.	220/440	CS-874
150	900	G.E.	220/440	K-6334
125	900	G.E.	220/440	K-556

SLIP RING MOTORS

HP	RPM	MAKE	VOLTS	TYPE
1000	1200	Al.-Ch.	4000	ANY
1000	900	Al.-Ch.	2300	ANY
700	720	G.E.	440	I-M
600	1200	G.E.	4160	M-6345
500	1200	G.E.	440	M-6345Z
400	1200	West.	2300	CW
400	720	G.E.	440	MT-573Y
350	1800	Al.-Ch.	2300	ARYW
300	900	G.E.	440	IM-17
300	450	G.E.	440	IM-16
250	600	West.	2300	CW-1000
200	514	West.	2300	CW-950A

MOTOR GENERATOR SETS

KW	MAKE	A.C.V.	D.C.V.
1750	G.E.	4160/2300	250/300
1000	West.	4160/2300	250
750	G.E.	4160/2300	250
600	G.E. (3 unit)	2300/440	125/250
500	G.E.	2300	250
400	Al.-Ch.	2300/440	125/250
250	G.E.	2300	250
200	G.E.	2300	250
150	West.	440	250

50 YEARS 1910 - 1960 SERVICE TO INDUSTRY

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

Phone CAnal 6-2900

CHICAGO Electric Co.

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 524 on Reader Service Card

4—125 KVA Transformers 2300 V to 160 V.
2—Rotary Convertors 800 Amp. 250 V. AC to DC.
1—Aldrich High Pressure Pump with 400 H.P. Motors 500 g.p.m. at 1200 p.s.i. Ingersoll Rand Compressor 60 H.P., 1,000 p.s.i.

PROCESS EQUIPMENT SALES CORP.
4205 Fullerton, Detroit 38, Michigan

Circle 525 on Reader Service Card

BOILERS

From the unfinished Battle Cruiser "Hawaii"

Material installed completely and never used.

7 Babcock & Wilcox Watertube Boilers

Approximately 157,000 lbs/hour. Working pressure 600#—850° T.T.—Oil-fired—with all boiler trim. Units are complete with fuel oil burning equipment—feed water pumps—feed water heaters, etc. Units are in prime condition.

CAN BE LOADED AS A UNIT OR DISMANTLED AND SHIPPED IN SMALLER SECTIONS

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 526 on Reader Service Card

COMPLETE STEAM POWER PLANT

NORTH LITTLE ROCK, ARKANSAS

(5)—Combustion Eng. Co. 435 HP, 4620 sq. ft. water-tube boilers, 3-drum low-head, 300 PSI, 34,500 lb. Saturated Steam per hour. Gas fired, with oil stand-by system. Built 1943, used very little. *Can be Sold or Leased on Site.*

PERRY EQUIP. CORP.
1422 N. Sixth St.
Philadelphia 22, Pa.
POplar 3-3505

Circle 527 on Reader Service Card

LIQUIDATION

of the Boiler and Generator Plant

of the

City of Paterson, New Jersey at—

72 McBride Avenue, Paterson, New Jersey

3750 K.W., G.E. 175#, 3/60/2300, Turbo Generator, Condensing.
2500 K.W. G.E. 175#, 3/60/2300, Turbo Generator, Condensing. (Can be operated non-condensing.)
50 K.W., G.E., Motor Generator Set 3/60/2200 in, 125 d.c., out.
Janesville turbine driven Boiler Feed Pump, 200 g.p.m., 250# discharge pressure.
2—Warren, m.d. Boiler Feed Pumps, 90 g.p.m., 250# discharge pressure.
1—New G.E. 60 h.p. to 15 h.p. Variable Speed Motor, 1175 r.p.m. to 585 r.p.m., 3/60/440, complete with automatic variable speed push button control.
2—4' x 8' Permutit Water Filters, 150 g.p.m. each.
1—16' dia x 8' high Cypress Storage Tank, 15,000 gal. capacity.
1—6' x 8' Cypress Tank, 1000 gal. storage.
Filter System and Tanks installed in 1951. Equal to new condition.
1—35' Wooden Platform Howe Scale. 20 ton.
1—Suspended Howe Scale with rails, used for coal, 2000# capacity.
A number of banks of transformers from 7½ K.W. to 500 K.W. single phase, 60/2300V to 480/240V.
1—50' span O.H. Crane, 15 ton, all hand operated from floor. Lift 30 ft.

All equipment easily accessible and can be removed through existing door without extensive dismantling.

This equipment will be priced for quick disposal.

SHERB PLANT CONSTRUCTORS
(Liquidators)
BOX 2406
PATERSON, NEW JERSEY
LAmbert 3-2500
or
377 South Harrison Street
East Orange, New Jersey
ORange 4-2943

Circle 529 on Reader Service Card

FOR SALE

Compact Boilers
in Excellent Condition
From Dismantled Liberty Ships
Designed Pressure 250 P.S.I.
Steam Per Hour: 24000 lbs.
Heating Surface:
Boiler 4852 Sq. Ft.
Superheater 264 Sq. Ft.
Superheated Steam: 16,500 lbs/hour—
Saturated 7500 lbs/hour
Superheater Outlet Temp: 450°F
Working Pressure at Superheater Outlet 200 P.S.I.
Length 16'7", Width: 14'8", Height: 15'4"
Located
New York, Tampa, Panama City, Fla., San Fran.
HUGO NEU CORPORATION
45 Nassau St., New York 5, New York

Circle 528 on Reader Service Card

MOTOR GENERATOR SETS

Q	KW	MAKE	D.C.	A.C.	RPM
3	750	West.	250	3/60	900
3	750	G.E.	250	3/60	720
1	500	Elliott	125	3/60	720
2	300	G.E.	250	3/60	1200
1	150	West.	250	3/60	1200
1	100	Star	250	3/60	1200

STEAM- TURBO- GENERATORS 3/60

Q	KW	MAKE	TYPE	I.S.P.	YEAR
1	10000	West.	Cond.	275	1932
1	7500	G.E.	Cond.	275	1948
2	7500	West.	Cond.	400	1945
1	5000	West.	Cond.	400	1938
1	3000	G.E.	Cond.	400	1940
1	1000	Elliott	N. Cond.	325	1930
2	1000	Elliott	Cond.	150	1949
2	300	G.E.	Cond.	400	1945
1	300	Al. Ch.	N. Cond.	175	Late
1	200	Worth.	Extr. Cond.	250	1948

PACKAGE BOILERS

Q	HP	MAKE	W.P.	FIRING	YEAR
6	80,000	B&W	200	Pulv.	1947
4	500	Cl. Bk.	200	Oil	1942
1	200	Superior	125	#6	1957
1	200	Erie	160	#6	1951
1	150	Cyclotherm	150	#6	1947
1	150	Cl. Bk	15	#6	1936
1	70	Ames	15	#2	1951

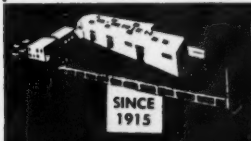
DIESEL GENERATOR SETS

Q	KW	MAKE	VOLTS	RPM
2	2000	Baldwin	230V.D.C.	257
2	1000	G.M.	3/60/2400	720
1	330	Worth.	3/60/480	600
1	300	G.M.	3/60/220-440	1200
1	50	Superior	3/60/220	1200
2	200	G.M.	3/60/220-440	1200
2	125	Worth.	3/60/480	600

AIR COMPRESSORS

CFM	PSI	MAKE	TYPE	H.P.	VOLTAGE	RPM	YEAR
7550(2)	24/30	I.R.	XHE	600	3/60/4160	300	1948
6000	125	Sullivan	H	1250	3/60/2300	200	1948
1853	125	Worth.	DC-2	300	3/60/2300	277	1946
1700(2)	125	C.P.	OCE	125	3/60/480	277	—
1530	125	Worth.	OXP	250	Steam	200	1948
2000(2)	100	Fuller	Rot.	300	3/60/2300	600	1942
676(2)	125	C.P.	OCE	125	3/60/480	277	—
515(4)	125	I.R.	40	100	3/60/440	870	1940/50
494	125	I.R.	XRB	75	3/60	277	—
464	100	I.R.	ES-1	75	3/60	300	1950
368	100	I.R.	ER-1	60	3/60	277	Late

"Everything from a Pulley to a Powerhouse"



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R. M. REGISTERED U. S. PATENT OFFICE

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• Cable Address OBRIEN PHILA.

MERCHANTS—CONSULTING ENGINEERS—EXPORTERS

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1937 W. CLEARFIELD ST., PHILADELPHIA 32, PA.

Circle 530 on Reader Service Card

COMPRESSORS

No better values at any price

100 CFM	150 PSI	6x7 Ing. ES-1
138 CFM	100 PSI	7x7, Ing. ES, CP & Joy
258 CFM	500 PSI	9½-4¼x11 Ing. ES2 (New)
288 CFM	100 PSI	9x9 Ing. Worth. CP
321 CFM	125 PSI	10x11 Ing. ES-1
344 CFM	1500 PSI	Ingersoll ES-3
380 CFM	40 PSI	12x9 Gard. (New) Ethylene
456 CFM	350 PSI	12-6x13 Worth HB2
465 CFM	100 PSI	12x11-1R-ES-1" Chic. P.T.
502 CFM	125 PSI	12x13 Worth HB
676 CFM	125 PSI	15-9¼x12 Ing. XRE
	125 Syn.	3-60-440-277 RPM
686 CFM	100 PSI	14x13 Ing. ES
1855 CFM	100 PSI	23-14x14 Ing XRE
	300 HP GE	Syn 3-60-440 (2) 1952
2200 CFM	110 PSI	26/15x18 Chicago Pneumatic
	OCE .8PF	350 HP Syn. 3/60/4160

AMERICAN AIR COMPRESSOR CORP.

48th & P, North Bergen, N.J. UN 5-1397

Circle 531 on Reader Service Card

75 TON BRIDGE CRANE

1—75 Ton capacity Whiting Mfg. Co. bridge crane with auxiliary hoist, 51 ft. span, complete with operating motors, control and rail.

Excellent condition.

Can be inspected in operation.

UTILITIES MACHINERY CORP.
1965 EAST SIXTH STREET
CLEVELAND 14, OHIO

Circle 532 on Reader Service Card

SKINNER VERTICAL UNIFLOW

250 KVA, 480 volt, 3 phase, 60 cycle Skinner, 2 cylinder vertical used universal uniflow generating unit, steam pressure 150 to 175 pounds throttle pressure, 2 to 5 pounds back pressure.

Available for Immediate Shipment
From Original Foundations in Illinois.

FRANK M. BEESON ENGINEERING CO.
1511 W. 27th St., Los Angeles 7, Calif.
RE 5-9820

Circle 533 on Reader Service Card

AUTOMATIC and MANUAL
Gas or DIESEL GENERATOR UNITS

Complete Switchboard Design and Construction

USED & REBUILT EQUIPMENT

UNIVERSAL POWER ENGINEERING CO.
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

Circle 534 on Reader Service Card

FEATURED ITEMS

BOILERS

44500 #/hr CE 450 PSI @ 750°F NEW
35000 #/hr CE 285 PSI @ 577°F NEW
18000 #/hr Keeler CP 160 PSI
620 #/hr Cyclotherm 250 PSI

MOTORS—Class I Group D

350 HP Al. Ch. 3/60/2300/450 RPM
250 HP Cont. 3/60/2300/720 RPM
250 HP Al. Ch. 3/60/2300/3600 RPM
250 HP G.E. 3/60/2300/3600 RPM
200 HP G.E. 3/60/2300/3600 RPM
150 HP Al. Ch. 3/60/2300/3600 RPM

AIR COMPRESSORS

7500 CFM @ 42.5 PSIG Al. Ch. Cent. 1250 HP
1360 CFM @ 35 PSI Worthington YO 150 HP

TRANSFORMERS

2000 KVA West. 13200—120 1/60
2000 KVA Al. Ch. 33000—2400 3/60—(2)
500 KVA Al. Ch. 2400—480 3/60
6000 KVA 44000—4160 3/60 Substation

FURNACE TRANSFORMERS

4450 KVA West. 1/25/1100—80 to 140V (2)
3125 KVA G.E. 1/60/13200—95 to 155V (6)
2500 KVA West. 1/60/1150—95 to 155V (3)
2500 KVA West. 1/25/1000—70 to 140V

GENERATOR SETS

1250 KVA G.E. 3/60/2300/3600 Cond. 200 PSI
750 KW 3/60/2200/900 RPM 250 V DC MG Set

HEAT & POWER CO. INC.
60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 535 on Reader Service Card

DIESEL ENGINE

1 HEAVY DUTY NORDBERG

Type TSM—model 32118—1700 HP @ 180 RPM — 21½" x 29". Unit complete with all pumps and coolers. Can be used for generator drive, producing 2400 HP @ 225 RPM. Equal to new. Presently in Maritime Academy.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

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TRANSFORMERS—60 CYCLE

QU.	KVA	MAKE	TYPE	PHASE	VOLTAGE
2	3000	Moloney	TCR	3	7200-4160/2400
2	3000	G.E.	OA-T	3	26,400-4160/2400
1	1500	West.	O.I.S.C.	3	26,400-480 taps-hi
2	300	G.E.	K.S.T.Q.	1	4150-2406
1	300	Penna.	OA Askarel	3	12,470Y/7200-240
3	200	Amer.	C.C.	1	4160/7200-240/480
3	200	G.E.	HS-W2S	1	2400/4160-240/480
3	75	G.E.	H-form KF	1	2400/4160Y-120/240
3	50	G.E.	H-form K	1	2400/4160Y-220/440
3	50	Niagara	Dry-air	1	2400/4160Y-120/240
3	50	Harrison	Dry-air	1	2400/4160Y-220/440

MOTOR GEN. SETS

QU.	KW	MAKE	SPEED	D.C.	A.C.
1	1000	West.	720	600	2300/4160 S.R.
1	400	West.	900	250	3 unit 4160 V. syn.
1	300	G.E.	1200	250	2300/4160 syn.
1	300	Al. Ch.	1200	125/250	3 unit 440 syn.
1	175	West.	1200	125	4160 syn.
1	100	West.	900	230	4160 syn.
1	45	G.E.	1170	30	440V Sq. Cage
2	50	G.E.	1760	230	440Y Sq. Cage

D.C. MOTORS—230 VOLT

QU.	HP	MAKE	SPEED	TYPE
1	350	G.E.	1200	ped. type
1	90	G.E.	1750	CDM
1	30	West.	1750	SK-113
1	30	G.E.	2200	CD-85
1	15	Crocker Wh.	1750	CCM, TEFC

SLIP RING MOTORS

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	500	G.E.	450	MT-422Y	2200
1	450	West.	1800	CW 4-30-9	2200
1	350	West.	1800	CW	2300
1	300	G.E.	1170	1-15 A	4150
1	200	West.	585	CW	440
3	150	Al. Ch.	1760	AY-RW	2300
2	150	G.E.	590	1-16	4000
1	100	West.	1770	TEFC B.B.	220/440
1	75	West.	1160	CW 607	220/440
1	75	West.	600	CW 774C	220
1	50	G.E.	570	MT 552	220/440

SQUIRREL CAGE MOTORS—3 phase—60 cyc.

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	300	Al. Ch.	1200	TRW	2200
1	300	G.E.	1800	6336S B.B. Drip	4160/2400
1	275	G.E.	1180	KT 559BS	2200
2	250	G.E.	1790	KTEFC B.B.	2200
2	150	G.E.	1780	K 6325-S XP B.B.	440
2	100	Cont.	3570	NP 585-S XP B.B.	440
1	75	Cont.	3565	NP5058X XP B.B.	440
1	75	G.E.	875	KT 552Y	440
1	50	G.E.	3530	KF 406Y Vert.	220/440
1	50	Cont.	3530	NP 445X XP B.B.	220/440

MOTORS—SYNCHRONOUS 3 ph, 60 cyc.

HP	SPEED	MAKE	TYPE	VOLTS
325	900	West.		2300
400	450	West.	HB	440
300	720	Bl. Mh. TEFC		2300
200/100	720/360	West.		4150
150	3600	G.E.	TS 956Y drip	2300
150	1800	G.E.	TS	220/440
150	900	West.		220/440
125	900	G.E.	TS 7536	2300
125	600	G.E.	TS 7641	2200
75	1200	Cr. Wh.	ALT B.B.	220/440

FOR POWER
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-3222
PHONE NEW JERSEY—UNION 3-2600

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APPARATUS EXCHANGE — Two Rector St., New York 6, N. Y.

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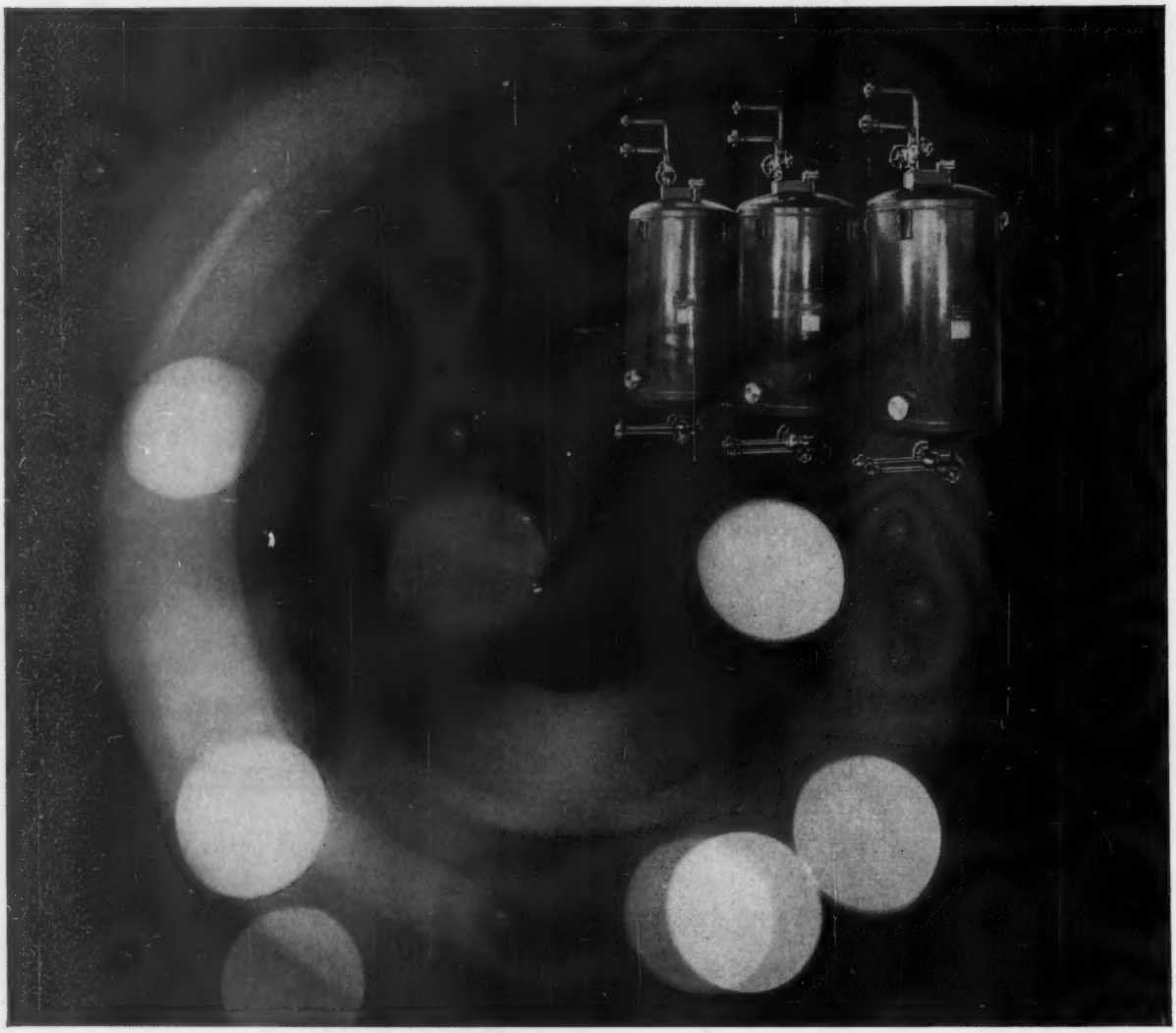

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PLUMBING • HEATING • AIR CONDITIONING

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Circle 202 on Reader Service card for Clayton Ad ➤

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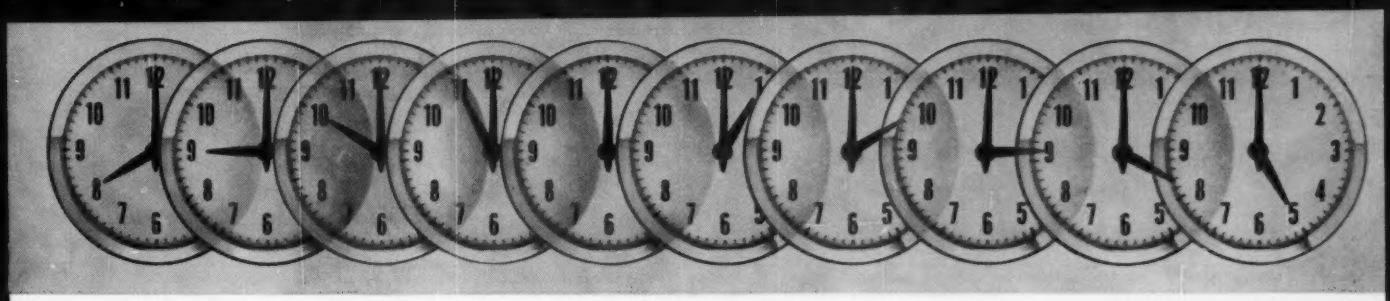

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175 HP (5000 PPH)
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Steam Generators

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426

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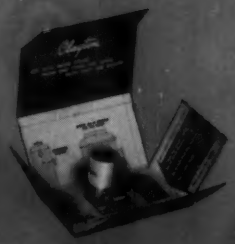
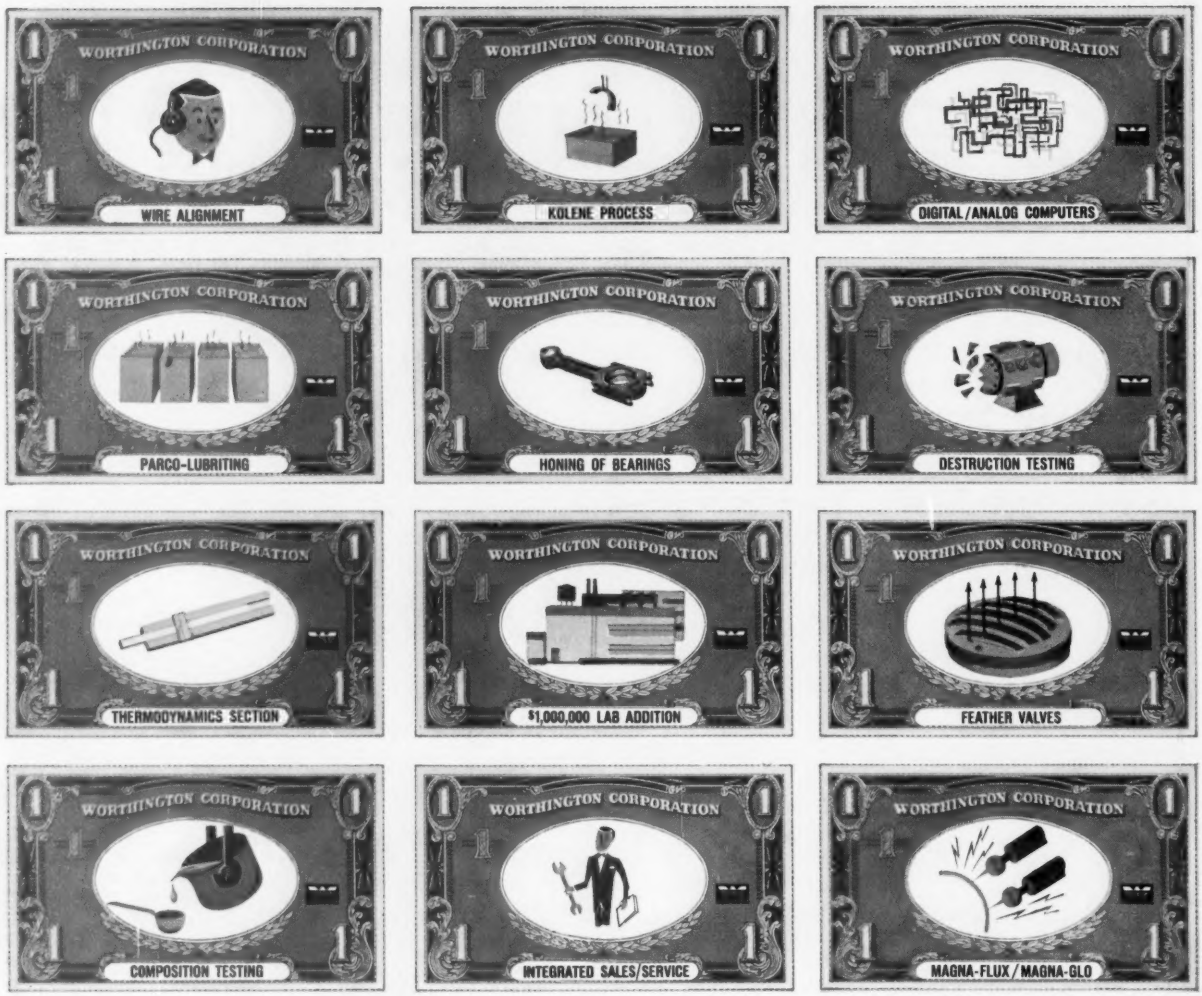


COMPRESSOR DOLLARS



WHAT'S IN THE PRICE?

These are dollars that are paid out every day for Worthington compressors. They reveal a few of the extra or "hidden values" that make the compressors worth most for the dollars invested. But even more important, they give a clue about real compressor values.

Today, rising costs and minimum profits compel every buyer to scrutinize compressor dollars more closely—to make sure they contain a full measure of value. In fact, your problem in determining the true value of a quotation is more difficult —but more important—than ever before.

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To help you isolate and evaluate competitive compressor offerings, we have prepared an objective "Compressor Evaluation Guide." This booklet points out the six key areas of judgment required for compressor evaluation and details them in full. Ask your Worthington Representative for this booklet or write Worthington Corporation, Dept. 36-18, Clinton Street and Roberts Avenue, Buffalo, N. Y. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

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